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# Use of Social Techniques in the PersonAAL Platform

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# Resumo

Com os avanços tecnológicos na área da saúde e consequente aumento da esperança média de vida, os números relativos à população idosa também aumentaram. Com o seu aumento, novos desafios relativos à manutenção de uma boa qualidade de vida na terceira idade foram surgindo, como garantir a sua independência o maior tempo possível evitando assim a hospitalização e institucionalização dos idosos.

O isolamento social é um dos problemas com que a população idosa se depara, podendo ter consequências graves na sua saúde, uma vez que afeta tanto o seu bem-estar psicológico como o seu bem-estar físico. O agravamento das capacidades cognitivas e da saúde mental bem como a participação em comportamentos nefastos como fumar, beber em demasia e levar uma vida sedentária são algumas das consequências do isolamento social, podendo ter como consequência o aumento da mortalidade. As suas causas podem variar desde aspetos físicos como o declínio dos sentidos, estilos de vida, educação ou mesmo mudanças no aspeto socioeconómico como a diminuição dos rendimentos.

Para combater este fenómeno são necessários métodos que tenham sucesso em persuadir o idoso a manter-se socialmente ativo. O trabalho desenvolvido nesta área é significativo, com várias aplicações já desenvolvidas ou em fases iniciais de projeto. Da literatura analisada no âmbito deste trabalho puderam dividir-se estas aplicações em varias categorias, desde o tipo de comunicação que oferecem entre os utilizadores; o público ao qual se destina, podendo algumas aplicações ter como foco principal a família ou pessoas com interesses comuns; o facto de ser necessário algum hardware adicional para além de um smartphone ou de um computador; se o foco é facilitar o acesso a redes socias já existentes; o tipo, caso existam, de monitorização ou visualização da atividade social dos utilizadores; e se permite o planeamento de atividades.

Este trabalho é integrado no contexto do projeto PersonAAL, centrado nos idosos e nos seus cuidadores, que tem como principais objetivos garantir que os idosos

possam viver independentes o maior tempo possível na sua própria casa, prestando auxílio na sua vida diária, tornando-os assim o menos dependentes possíveis da sua família e cuidadores, garantindo um bom nível de qualidade de vida. Para tal, faz uso de aplicações web intuitivas, permitindo aos utilizadores receber mensagens personalizadas, incorporando tecnologia também personalizada para garantir que as soluções fornecidas sigam de encontro às necessidades e capacidades dos utilizadores.

São vários os componentes e aplicações que fazem parte da plataforma PersonAAL, desde o *Aunthentication Server*, responsável pela autenticação dos utilizadores da plataforma e proteção dos seus dados; o *Context Manager* que trata de recolher, armazenar e gerir informação recolhida por sensores ou inserida pelos utilizadores nas diversas aplicações; a ferramenta *Aunthoring Tool* onde os utilizadores podem criar, apagar e editar regras permitindo assim personalizar as aplicações e os mecanismos persuasivos; o *Adaptation Engine* que faz a comunicação entre as aplicações e o *Context Manager* enviando as mensagens personalizadas para os utilizadores ou outras ações; o *Persuasion Module* cujo principal objetivo é a criação de mensagens persuasivas procurando incentivar comportamentos positivos e alterar comportamentos negativos; a aplicação *Medication Monitor* que fornece aos utilizadores ajuda na monitorização dos medicamentos a tomar; a aplicação *Activity Tracker* que procura manter ou aumentar os níveis de atividade física do utilizador fornecendo uma forma de o utilizador escolher e planear um programa de exercícios; e a aplicação *Remote Assistant* onde é dado ao utilizador várias funcionalidades como a visualização de certos valores de saúde, a visualização e edição do seu perfil, adição de interesses e contactos, alterar os níveis de luz na sua casa e a possibilidade de marcar objetivos semanais relativos a atividade física ou social e planear as respetivas atividades no calendário.

Os objetivos deste trabalho centram-se assim em identificar técnicas socias que possam ser adotadas no contexto do projeto PersonAAL; implementar essas técnicas, permitindo que o utilizador receba mensagens personalizadas de acordo com o seu comportamento; modificar o *Persuasion Module* e o *Remote Assistant* para que sejam possíveis a implementação das novas técnicas sociais e explorar métodos de recolha de informação relativos à atividade social do idoso.

A aplicação *Purple Robot* foi uma das ferramentas analisadas. Esta faz uso dos sensores dos dispositivos móveis onde se encontra instalada, para recolha de informação

sobre o utilizador e aquilo que o rodeia desde redes Wi-Fi, dispositivos Bluetooth, a sua localização, aplicações instaladas no dispositivo, histórico de mensagens e chamadas, entre outros. Esta informação seria então armazenada numa base de dados criada para o efeito.

No entanto devido a preocupações relativas à privacidade e proteção de dados dos utilizadores, foi decidido não utilizar este método de recolha de informação, procurando então adaptar a aplicação *Remote Assistant* às novas necessidades.

O *Persuasion Module* também teve de sofrer alterações de forma a poder acomodar técnicas persuasivas com maior nível de complexidade, visto este ser um requisito identificado pelos parceiros clínicos do projeto. Embora inicialmente o foco desta tese tenha sido a componente social, foi importante não descartar a componente física tendo sido também criadas novas regras tanto para persuadir o idoso a praticar exercício físico como para participar em atividades sociais.

Estas regras foram criadas em colaboração com psicólogos e focam-se em persuadir o utilizador a marcar objetivos semanais e cumpri-los. Estes objetivos prendem-se com o número de atividades sociais em que o utilizador pretende participar, assim como o número de horas passadas a praticar exercício físico e a caminhar. Os métodos persuasivos são aplicados através de mensagens que, para além de relembrar o utilizador de atividades marcadas, mostram também o seu progresso em relação aos objetivos, motivam o utilizador a alcançá-los e felicitam-no quando estes são atingidos.

Para tal as regras são então expressas em ficheiros java no *Persuasion Module* e os vários valores associados ao utilizador (vindos do *Fitbit* e *Remote Assistant*) são utilizados como parâmetros para disparar as regas e consequentemente para gerar as mensagens persuasivas.

As alterações efetuadas no *Persuasion Module* focaram-se nos seus últimos três módulos e respetivas tabelas na base de dados. Devido à crescente complexidade das regras face à versão anterior e à diferente forma de recolha de informação relativa à atividade física e social do utilizador, os dois primeiros módulos, que se relacionam com padrões de atividades e desvios a esses padrões, não foram utilizados.

O terceiro módulo (*COMBFinal)* verifica se os URLs, de onde vai ser obtida a informação relativa ao utilizador para ser utilizada nas regras, são válidos. De seguida, no quarto módulo (*BCTSelectionFinal),* os URLs validados pelo módulo anterior são acedidos e os seus valores usados como parâmetros nos ficheiros das regras de forma a

dispará-las. Uma vez disparadas a regras, o quinto e último módulo (*BCTInstanceFinal)* gera as mensagens associadas com as regras (que podem ser genéricas ou personalizadas com informação referente ao utilizador) e constrói a mensagem final que será enviada para o *Adaptation Engine* e consequentemente para o utilizador.

De forma a poder utilizar a maior quantidade possível de informação relativa aos utilizadores no *Persuasion Module* para que as mensagens persuasivas criadas possam ser o mais personalizadas possível, foi também necessário fazer alterações na aplicação *Remote Assistant.*

Numa primeira instância foi necessário enviar a informação recolhida pela aplicação *Remote Assistant*, ainda em falta, para o *Context Manager*, como o idioma escolhido, os objetivos semanais a nível de exercício, caminhar e social, informação relativa às atividades completadas, contactos e perfil do utilizador.

Foram efetuadas também algumas mudanças em termos de informação exposta em cada página da aplicação *Remote Assistant*, onde certas secções foram movidas para páginas diferentes. Na página *Home* foi adicionado uma nova secção onde é exposto o número de passos do utilizador para a semana corrente, conseguido através do *Fitbit*.

A página *Plan* foi onde se concentraram as mudanças mais importantes tanto na secção onde o utilizador insere os seus objetivos semanais e visualiza o seu progresso, como na secção do calendário permitindo o planeamento de atividades físicas e sociais. Ao clicar numa célula do calendário, o primeiro passo consiste em confirmar a data e hora da atividade. De seguida, é selecionada o tipo da atividade (*exercise, walk* ou *social*) e por último seleciona-se a intensidade da atividade que varia de acordo com o tipo escolhido no passo anterior. Uma vez completado este processo, a atividade é enviada para a base de dados e adicionada ao calendário (mostrando as atividades em cores diferentes dependendo do seu tipo). Como também é possível marcar atividades com a aplicação *Activity Tracker,* essas atividades passaram a ser visíveis também no calendário da aplicação *Remote Assistant.*

Para o *Persuasion Module* poder utilizar, nas suas regras, informação relativa às atividades planeadas no calendário, foi necessário também criar um serviço REST possibilitando o acesso a essas atividades.

Por fim, a aplicação *Remote Assitant* e o *Persuasion Module* (juntamente com toda a plataforma PersonAAL) foram testados por três utilizadores durante algumas semanas, a quem foi pedido para tentar incorporar as funcionalidades disponibilizadas

nas suas atividades diárias e assim contribuíssem para a avaliação da sua facilidade de uso, e também que fizessem uma apreciação das mensagens persuasivas que foram recebendo durante o período de testes.

De um modo geral, ao testar a página *Plan* na aplicação *Remote Assistant*, os utilizadores realizaram as tarefas com facilidade com algumas exceções. Um utilizador considerou que adicionar uma atividade no calendário requeria muito esforço ao indicar as horas de início e fim da mesma.

No que diz respeito às mensagens persuasivas, um dos utilizadores reportou que não recebeu as mensagens durante os testes, mas sentiu que as mesmas podiam aumentar os seus níveis de atividade física e social. Os outros dois utilizadores consideraram que as mensagens não os persuadiam a ser fisicamente e socialmente mais ativos, mostrando que ainda existe trabalho a realizar relativamente ao conteúdo das mensagens persuasivas. No entanto foi possível verificar que o sistema funcionava corretamente, sendo as mensagens geradas e enviadas para o utilizador.

Foram assim cumpridos os objetivos propostos, tendo sido identificadas e implementadas técnicas persuasivas no contexto do PersonAAL. Para tal foram modificados certos elementos do *Persuasion Module* e da aplicação *Remote Assistant* e foram também explorados métodos de recolha de informação relativas à atividade social do idoso, tendo sido analisado a aplicação *Purple Robot.*

Como trabalho futuro, existem ainda vários elementos que podem ser melhorados como a natureza das mensagens persuasivas e como estas devem ser adaptadas para melhor motivar os utilizadores. As mensagens poderiam também tornar-se interativas, permitindo, por exemplo, ao utilizador indicar se pretende realizar a atividade que a mensagem está a sugerir. Também na aplicação *Remote Assistant*, de forma a promover mais interações sociais, se poderia implementar um sistema de troca de mensagens, podendo depois essa informação ser utilizada para a criação de novas regras.

**Palavras-chave:** isolamento social, idosos, métodos persuasivos, personaal

# Abstract

With the technological advances and consequently the rise in the average life expectancy, the numbers related to the elderly population also rose. With that, new challenges in maintaining a good quality of life at a later age were born. Social isolation is one of the problems faced by the elderly population, which can have serious consequences on their health, since it affects both their psychological well-being as well as their physical well-being and is even related to high mortality rates. The causes of social isolation can range from physical aspects, lifestyles, education or even socioeconomic aspects. Inserted in the context of the PersonAAL platform, the goals of this thesis are to identify social techniques that will lead the elderly to have a more active social life, explore methods of retrieving information about the user's social life to implement those techniques and modify two applications part of the PersonAAL platform (*Remote Assistant* and *Persuasion Module*) so that the new social techniques can be implemented. The *Purple Robot* application was one of the tools analysed that allowed to retrieve data regarding the user's location, applications used, call and message logs, Wi-Fi networks and Bluetooth devices in the user's surroundings. That data would have been stored in a database but due to concerns regarding data protection it ended up not being used. In the *Remote Assistant* application, besides adapting the support for setting physical and social goals, a new calendar was implemented, for the user to schedule physical and social activities as well as a REST service to access that information. The *Persuasion Module* also had to be modified in order to use new sources of information and to support the creation of more complex rules to generate persuasive messages customized to the user's needs. In the end, while the persuasive messages were sent to the users correctly, more work needs to be done regarding the messages' content to fully motivate the users to be more active.

**Keywords:** social isolation, persuasive methods, older adults, personaal

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# Chapter 1

# Introduction

In the last decades there was a constant rise of the ratio of the elderly population in Portugal due to a decrease in the number of births, an increase in life expectancy, as well as a growth in emigration in the younger demographic. According to a United Nation's study (United Nations, 2015), in the next 35 years, the Portuguese elderly population will represent 40% of the habitants, making Portugal the fourth country in the European Union with the oldest population.

One of the main goals of a nation with a significant percentage of elderly population is to find ways for them to live independently for as long as they are able and try to avoid hospitalization (Mistry et all., 2001) and institutionalization (Brock & O'Sullivan 1985).

One way to guarantee that is to make sure the elderly has the necessary living conditions to do so and is supported by a social network in case some kind of assistance is necessary. But as age advances, people tend to lose some contacts and isolate themselves in their homes.

Social isolation can be described as the shortage of contact and interactions between the person and his social network (Gardner et al. 1999) and there are many factors that can contribute to this condition in the elderly population. Physical aspects such as progressive loss of senses (hearing, vision, cognition and motor) (Heine, Erber, Osborn, & Browning, 2002), incontinence problems (Iglesias et al., 2000), one's bad perception of their body image can prevent the elderly to engage in social activities because they feel embarrassed or self-conscious (Christakis & Fowler, 2007).

Low education levels (Iliffe et al., 2007), early retirement and subsequent lack of purpose in life or a loss of a loved one (Wenger&Burholt, 2004) can also prevent the elderly to engage in social activities. The same way, changes in socioeconomic status leading to lower income as well as living in an area where they don't feel safe going

outside tend to keep the elder confined to his house (Ross & Jang, 2000). Living alone and stopping going to church or participating in other collective activities can also isolate even more the elderly (Berkman & Syme, 1979).

## 1.1 Motivation

Social isolation can have dire consequences on the elders' health and overall well-being (Nicholson et al. 2012). It can lead to negative behaviours like smoking, heavy drinking (Hanson, 1994) or taking a more sedentary life (Eng et al.,2002). A decline of nutritional values (Locher et al., 2005), an increased risk of falls, rehospitalization and institutionalization are also associated with it (Brock & O'Sullivan 1985).

The impact in the physiological well-being is also a consequence of social isolation, demonstrated by the increased chances of dementia and cognitive decline of the elderly. There is an important relationship between social isolation and mental health where elders are more susceptible to depression and consequently suicidal thoughts (Nicholson et al. 2012).

By interacting with other people, the elderly forms a social network that can be of assistance in case help is necessary or the reassurance they have someone to contact if they desire. One of the benefits of having a social network is associated with a higher participation in routine health checks than the ones who are not socially connected (Stafford et al. 2018).

Technology can have a key role in preventing social isolation and several interventions have already been offered to increase the levels of social connectedness in the elderly population with various degrees of success. Still, while some of these applications try to promote a healthier social lifestyle by either facilitating the access to social media and other communication related applications or creating new innovative ways to keep the user socially active, none takes into consideration the aftermath of the user's activities. They are focused in finding different and accessible ways for the user to communicate and hope it will be enough for the user to remain motivated in using them.

## 1.2 Context

This thesis is inserted in the context of the PersonAAL[1] project, financed by European funds and with partners established in four different European countries: Italy, Portugal, Norway and Sweden. It's formed by a multi-disciplinary consortium that includes two large companies (Reply from Italy and IBM from Norway), a SME (Plux from Portugal), three scientific/research institutes (CNR-ISTI from Italy, USI from Switzerland and FCUL from Portugal), one healthcare institution (SUNRH from Norway) and one End-User Organization (terzStiftung from Switzerland).

PersonAAL is centred not only around elderly people as its end users, but also their formal and informal caregivers. Its main goals are to extend the time the elderly can live independently in their own homes by providing web applications customized to the elderly enabling them to receive context-dependent assistance in their own homes, improve quality of life and decrease healthcare delivery cost.

In 2017, another thesis was written in the same context (Silva, 2017), focused on the user's physical activity and PersonAAL's *Persuasion Module*, where through behaviour changing technologies sought to modify bad behaviours and reinforce positive ones.

This thesis, while still dealing with the physical domain, will explore the social domain focusing on modifying the *Persuasion Module* but also *the Remote Assistant*, an application where the user can, besides other things, plan his social and physical activities.

Given some of the limitations within PersonALL in collecting information regarding the user's social activities, other methods had to be explored besides relying only on information given directly by the user in the *Remote Assistant* application.

## 1.3 Goals

Given the reasons mentioned in the Introduction and Motivation sections, keeping the elderly population connected with their social circle is of the utmost importance. With that, and the context of the PersonAAL project, in mind, the overall goals of this thesis are:

[1] http://www.personaal-project.eu

- Identify social techniques that can be adapted in the context of the *PersonAAL* project;
- Explore methods of retrieving information regarding the user's social life, necessary to implement the identified techniques;
- Implement those techniques allowing the user to receive personalized messages in accordance with their behaviour;
- Modify the *Persuasion Module* and the *Remote Assistant* application so that the implementation of the new social techniques is possible.

## 1.4 Document Structure

This document is structured in eight chapters presenting all the different aspects researched, designed, implemented and evaluated that allowed to write this thesis.

After an introductory chapter containing the overall theme, motivation and the project's context, the chapter 2 (Related Work) is where existing applications associated with the elderly population and their social life are analysed and discussed.

Chapter 3 (PersonAAL) presents the PersonAAL platform in its state at the beginning of this work, explaining its architecture and the different components, as well as limitations.

Chapter 4 (Purple Robot) gives an overview of the *Purple Robot* application and its components, as well as the challenges to integrate it in the PersonAAL platform and is related to the method found to retrieve information regarding the user's social activity.

Chapter 5 (Design) explains the requirements and necessary changes in the *Remote Assistant* application and *Persuasion Module*. The following chapter 6 (Implementation), details how the solutions were implemented, as well as the tools, programming languages and frameworks used.

Chapter 7 (Evaluation) shows the results of the software tests and the integration of the changes made into the PersonAAL system as well as qualitative analysis of the field trials.

Finally, in chapter 8 (Conclusion), the thesis is concluded by discussing the results, how the goals set in the first chapter were met and the possibilities for improvement in future works.

# Chapter 2

# Related Work

After searching through articles that tackled the subject at hand, a sample which englobed systems that provide means for the elderly to be more socially active was selected. All the systems were different from each other in some capacity, so it was necessary to break down their components and methods used to fight social isolation. On a first approach, it was necessary to establish to whom the system was directed at, their hardware components and what functionalities it offered its users. Various categories were thought of and then refined throughout the process of analysing all the articles. The following paragraphs will explain how each one of the eighteen selected systems fit in a certain category and, given the different natures of each one, the systems will be revisited when necessary.

## 2.1 Focus

### 2.1.1 Family

The following applications were built with the strengthening of the relationship between the elderly and his close family in mind.

The Family Message Board (Rodríguez, M. D. et al. 2009) has the goal of making the elders feel more connected with family members living abroad by presenting an interface that allows the entire family to see the messages shared between them.

*TimelyPresent*'s (Kim, H. et el. 2013) aims to connect families whose members live far away from each other, and in this case, in different time zones. The goal is to use a device with which family members can create virtual gifts to send to another member.

One of the main goals of *SocialConnector* (Muñoz, D. et al. 2015) is taking the information that family members post on different social media platforms or send by email and make that content available to the elderly members of the family. Using a telephone metaphor, the system is fixed to a wall and elders can interact with the application using their voice and selection of icons on the touch-screen.

*KinCircle* (Baharin, H. et al. 2016) is presented as a social messaging app for family connection where the creation of family rituals and events are encouraged by a virtual avatar (*Virtual Kin Keeper*) and serves as well as a reminder of important dates. The application has an interface designed like a family home to symbolise the bond between the members.

### 2.1.2 People with shared interests

Other applications are focused on people with the same interests and serve as a mean to connect them.

One of *AgileLife*'s (Grosinger, J. et al. 2012) focus is for the user to find someone with an activity plan that makes the elder want to join them and exercise together. To do so, the users insert their training plan into the system that is then shared with the rest of the users. If the elder sees an activity he would like to join, he clicks in the option *attend*.

*Go-myLife* (Haritou, M. et al. 2013) provides contextual awareness of whom and what is around the user. This helps the user to find interesting information about places and add their own comments for the sake of others.

*FridgeNet* (Lee, Y. et al. 2015) tries to provide a way for people with interest in a healthy diet to go shopping for food together. The users can send invitations based on the same nutritional requirements for example.

*SAFER* (Ordoñez-Ordoñez, J. et al. 2017) uses the elder's profile to find other people in the surrounding area with the same interests so they can create a sporadic social group and attend an event together.

## 2.2 Extra hardware requirements

As mentioned earlier, one aspect that is important to acknowledge is if the system needs additional hardware to work and is not just installed in a computer/tablet/smartphone.

The *ShareTouch* (Tsai, T. et al. 2012) system merges a digital desktop with a physical table, using multi-touch technology to blur the gap between digital and physical worlds and easing the content's manipulation for elderly people. The system also contains an optic device supporting multi-touch functions, four microphones at each corner of the LCD to record and analyse user's voices and four RFID readers for user authentication.

Besides a network of sensors placed at the elder's house, whose main goal is collecting data regarding the health of the user or the environment that surrounds him, *GiraffaPlus* (Coradeschi, S. et al. 2013) also provides a telepresence robot, the *Giraff Robot*. This robot can be moved around the house, controlled by a caregiver and is equipped with a camera, display, microphones, speakers and a touch screen.

*TimelyPresent* (Kim, H. et el. 2013) uses a pair of Archos 9 tablets, set up as digital frames so that the family members can send and receive their virtual gifts.

The *YoooM* system (Achilleos, A. P. et al. 2013) has two webcams, two high resolution screens, a touch screen, a microphone and a pair of speakers. The first webcam is directed to the face of the user and the second webcam to his activity area (arms and hands). The two screens are aligned by a 135 degree angle which allows for a feeling of social presence and improves natural communication.

*StoryBox* (Wallbaum, T. et al. 2016) consists of a programmable board with connected buttons and RGB LEDs. The stories to be shared are created on top of a glass pane above a laser-cut wooden box.

At last, *You, me & TV* (2017) requires a PC, a remote control, a television set and a Kinect. The prototype runs on a PC connected to the TV that displays the content. The remote control allows interaction with the system and the Kinect is used to capture the printed photographs to be sent to relatives.

## 2.3 Facilitates access to social networks

Due to the difficulty that elderly people sometimes feel while trying to use some well-known social network websites, the following applications try to gather the content scattered across various platforms and present it to the user. The main goal is that the elderly should not feel left out by missing information that their family and friends post online and feel confident enough to post their own content.

*Go-myLife* (Haritou, M. et al. 2013) serves as a gateway through which the users can interact with other mainstream social networks not needing to have an account in each one. By using it, elderly people can view the status, comments and content shared by their friends and they are also able to respond, comment and interact with this content.

*Tlatoque* (Cornejo, R. et al. 2013) is a digital picture frame that communicates with the Facebook site and allows to expose photographs in the user's homes, serving as well as a mean to post information into Facebook.

*SocialConnector* (Muñoz, D. et al. 2015) serves as an intermediary for the elder to interact with family members that use social networks. It has four communication channels through which the elder can interact with: Skype video calls, emails sent by Gmail, messages on the Facebook wall and a photo display service.

*SSN: Senior Social Network* (Marcelino, I. et al. 2016) uses the YouTube API to allow users to see videos in the application and create and share their own videos.

*Senior App Suite* (Goumopoulos, C. et al. 2017) displays content gathered across social networks with an interface customized to the elderly population. The user can view the status, comments, multimedia content shared by their friends and can as well interact and provide feedback. The system also provides access to information regarding welfare services, the latest news classified in categories, selected YouTube channels related to seniors, weather forecast, maps and events based on the user's location.

*You, me & Tv* (Coelho, J. et al. 2017) provides a prototype of a multimodal, adaptive interface for Facebook on a television that allows elders to access what their friends and family published on Facebook as well as publish their own content. It also allows the publication of two new types of content: the TV show the senior is watching and digital copies of printed photos that the senior owns.

## 2.4 Monitoring/visualization

Some systems allow some degree of monitoring like visualizing his social circle, using the user's location or preferences

*AgileLife* (Grosinger, J. et al. 2012) aims to promote physical activity amongst the elderly using their friends as motivational factor. To do so, besides being able to plan

activities, the elder can also see his friend's planned activities and is able to join him if he wishes.

The *ShareTouch* system's (Tsai, T. et al. 2012) main interface is a lake where the user's friends are displayed as fishes. Therefore, the more friends one has, more fishes are going to be displayed in the lake, encouraging the user to make more friends so that more fishes appear.

*Go-myLife* (Haritou, M. et al. 2013) provides contextual awareness of whom and what is around the user, allowing meetings with friends and family. It also helps users to find information about places around them and add their own comments.

In *AMCOSOP* (Kivimäki, T. et al. 2013) it is possible to categorise one's contacts as distant or intimate and filter them when necessary. It is also possible to see which contacts are available for calls, because their photos will appear in a bigger size in the main screen.

By analysing the elder's profile and his preferences, the *SAFER* (Ordoñez-Ordoñez, J. et al. 2017) platform can also find the user's location and suggest events around him indicating place, date and time. The system also recommends the creation of sporadic social groups made up with elders of similar preferences so that the elder does not have to attend the event alone.

## 2.5 Communication

The type of communication that the applications support can be divided in synchronous communication and asynchronous communication. Although some systems support both, below they will be explored in separate segments.

### 2.5.1 Synchronous communication

The *GiraffPlus* system (Coradeschi, S. et al. 2013) uses a robot (*Giraff*) that moves around the elder's house. It uses an interface similar to the Skype platform, thus allowing the elder to communicate by video with his caregiver with the feeling of instant presence.

By using its webcams, high-resolution screens and their placement, the *YoooM* system (Achilleos, A. P. et al. 2013) improves natural communication via auditory and visual cues that provide a more realistic animation of human behaviour. To start a communication the user can navigate his agenda and select one person to initiate a one-

to-one call. The system also developed a “club module” that enables communication between multiple participants and a “classroom module” where one user is displayed in the centre of both screens as the “teacher” and the rest are positioned as students in the lower screen.

Based on a telephone metaphor, the *SocialConnector* (Muñoz, D. et al. 2015) is fixed on a wall and the system shuts down during the night and activate again in the morning. It also uses the Skype platform to make video-calls, so the users must have an account.

*The SSN: Senior Social Network* (Marcelino, I. et al. 2016) allows the making of video-calls.

With the *Senior App Suite* (Goumopoulos, C. et al. 2017) the user can make video calls and the system tries to facilitate daily activities by providing an easy accessed phonebook with useful phone numbers.

### 2.5.2 Asynchronous communication

The *Family Message Board* (Rodríguez, M. D. et al. 2009) allows the elder to send messages to a specific family member, but the messages are public to the entire family. The messages are displayed in the main board where the user can see the messages received and create his own messages to send to other family members.

When using *ShareTouch* (Tsai, T. et al. 2012), if the user wants to communicate with a friend, he clicks on the fish representing the friend in question and sends him a voice message using the microphone. It is also possible to share multimedia content by dragging the video or image towards the friend in question.

The *AMCOSOP* (Kivimäki, T. et al. 2013) allows the user to send and receive text messages to his contacts that will be displayed in the Details View of that contact.

Even if the user does not have an account in a social network, the *Go-myLife* (Haritou, M. et al. 2013) platform allows the users to comment on their friends’ posts in social networks as well as send messages.

*Tlatoque* (2013) serves as a facilitator to access Facebook, therefore allows that channel of communication.

With *TimelyPresent* (Kim, H. et el. 2013) the elder can send/receive virtual presents, like videos, to/from family members that live abroad in different time zones. To make a simple multimedia message more special the system uses a gift metaphor in

which there is a delay between sending and receiving so that the gift arrives at the same local time as it was created and the sender cannot keep the message that he created.

Besides monitoring the elder's nutrient intake, *FridgeNet* (Lee, Y. et al. 2015) shares that information amongst peers, so that a user can evaluate his diet by comparing it with other users. The system also lets users post comments, pictures and voice messages.

Besides video calls, the *SocialConnector* (Muñoz, D. et al. 2015) provides three more communication channels: private messages, public messages and photos. Private messages are emails sent through Gmail, public messages are messages posted on the user's Facebook wall and photo display acts as mechanism to trigger interactions amongst the elder and his family members but does not allow a direct interaction between the one who publishes the photo and the ones who see it.

Based on the WhatsApp application, the *KinCircle* (Baharin, H. et al. 2016) allows the creation of family groups where each member can send, receive and see messages. One difference is that when a user receives an invitation to join a group, he is not automatically added but has to agree first.

By using the *SSN: Senior Social Network* (Marcelino, I. et al. 2016) the elder can create and send his own video messages to his friends and family.

*StoryBox* (Wallbaum, T. et al. 2016) is not a system specifically made for elderly people, but for people who live far away to feel connected to their loved ones. It helps create visual stories and share them with friends and family members. These stories consist of multiple shots, which get combined to an animation. To send a story, the user can select a recipient from a list within the application or use one of the fast-send buttons on the box.

The *InTouch* (Judges, R. A. et al. 2017) platform supports only asynchronous communications and can send four types of messages. Short pre-set text messages, video messages that can be filmed and recorded, audio messages and photo messages. The elder adds his contact's email to the application and when a message is sent, it is received in the contact's email inbox with the media as an attachment.

Beside supporting video calls, the *Senior App Suite* (Goumopoulos, C. et al. 2017) also provides communication services such as sending videos, photos or messages to a selected person.

The news feed in *You, me & Tv* (2017) allows the user to publish content for his friends and family to see.

## 2.6 Activities Planning

Besides providing various forms of communication so that the elderly population can feel more connected to his family and friends, another way some systems use to fight social isolation is allowing the elder to organize social activities like meetings or events.

The *AgileLife* platform (Grosinger, J. et al. 2012) encourages the planning of physical activities using friendship as a motivational factor. Besides being able to plan his activities specifying the date and place, the elder can also see his friends planned activities and is able to join them if he wishes.

By facilitating the elders' access to social networks and engaging them in community activities, *Go-myLife* (Haritou, M. et al. 2013) is also a platform where the users can feel safe to organize events and manage those already created.

Besides promoting a healthy diet, *FridgeNet* (Lee, Y. et al. 2015) also encourages social interaction. With the *Buy2+gether* service, the elder can send invitations to other users so that they can go shopping for food together. These invitations can be sent to the nearest three neighbours, to friends and family or based on nutritional requirements.

*KinCircle* (Baharin, H. et al. 2016) is very focused on family rituals. An avatar, called the virtual Kin-Keeper, can suggest new events based on past family events or important dates and is up to the family's Kin-Keeper to use the system's function to create a new event. This function besides creating future events, can also turn current events in family rituals to strengthen family bonds, and can also serve as a reminder of events.

As mentioned before, *SAFER* (Ordoñez-Ordoñez, J. et al. 2017) recommends to the user events based on his profile and interests. The users are notified, and the information is sent to them, so they can agree.

*Senior App Suite* (Goumopoulos, C. et al. 2017) uses the elder's location and his preferences to show social events, conferences, etc., that take place nearby. The title, location and date as well as directions on a map are shown for each of the events.

| | Focus on family | Focus on people with shared interests | Needs additional hardware | Facilitates accsess to social networks | Monitoring/ visualization | Synchronous communication | Asynchronous communication | Activities planning |
|---|---|---|---|---|---|---|---|---|
| Family Message Board (2009) | X | | | | | | X | |
| Agile Life (2012) | | X | | | X | | | X |
| ShareTouch (2012) | | | X | | X | | X | |
| AMCOSOP (2013) | | | | | X | | X | |
| GiraffPlus (2013) | | | X | | | X | | |
| Go-my Life (2013) | | X | | X | X | | X | X |
| TimelyPresent (2013) | X | | X | | | | X | |
| Tlatoque (2013) | | | X | X | | | X | |
| YoooM (2013) | | | X | | | X | | |
| FridgeNet (2015) | | X | | | | | X | X |
| SocialConnector (2015) | X | | | X | | X | X | |
| KinCircle (2016) | X | | | | | | X | X |
| SSN: Senior Social Network (2016) | | | | X | | X | X | |
| StoryBox (2016) | | | X | | | | X | |
| InTouch (2017) | | | | | | | X | |
| SAFER (2017) | | X | | | X | | | X |
| Senior App Suite (2017) | | | | X | | X | X | X |
| You, me & Tv (2017) | | | X | X | | | X | |

*Table 1: Systems by category*

## 2.7 Discussion

In the end, eight categories were found (Table 1) with two related to the social groups the systems were directed at (family and people with shared interest), one related to the hardware components and five related to the functionalities offered (access to social networks, monitoring, two types of communication and planning activities). Some categories initially thought of were dropped like the possibility of playing games on the application or the focus on the user's location.

Regarding the systems' focus, five were built specifically with the family in mind, four to people with shared interests and nine did not specify. The family component is very important for the elderly since communication with family members is largely a driving force for the elderly to adopt a new technology (Damodaran et al., 2014). The systems that focused on interests were the ones that allowed planning activities and were not just a tool for digital communication.

Only six of the eighteen systems needed additional software. This is due to the fact that since the elderly population may need more time in getting familiarized with a completely new system, installing the application in their own smartphone is the best way to guarantee a certain degree of comfort and ensure an easier learning period. If the system requires many hours to understand how it can be operated and is completely

different from what the elder is already familiarized with, they most likely will not pursue it.

One way for the elderly to feel included in his social circle, be it family or friends, is to access social media networks like Facebook. Here they can stay in touch, see pictures of loved ones and participate in group activities by exchanging messages and other multimedia content, but it can be difficult since most of these platforms do not meet some usability needs of the elderly. Six systems focused on facilitating the elder's access to these social media platforms by simplifying interfaces and facilitating the process of exchanging information. Except for the *You, me & TV* that transports the social media platform to a television, the rest of the systems do not bring innovation to the table, only resolve usability issues.

It would also be helpful if more systems provided a different way for the user to visualize and manage his social network so that it could lead the user to want to increase his social circle. Only the *ShareTouch* (2012) system had the possibility for the elder to see his contacts in a new and innovative way by representing the contacts as fishes in a lake and not a simple list leading the user to fill the lake with more fishes by meeting new people.

The most obvious way of fighting social isolation is to provide a communication channel that the elderly can use and now that each system was analysed, it can be established that all systems, except *Agile Life* (2012) and *SAFER* (2017) offer at least one way of communication, be it synchronous or asynchronous. Agile Life only allows for activities to be planned and the visualization of other people's activities, and while SAFER suggests activities based on interests, it does not provide a way of communication with the people whom will join the activity.

Although synchronous communication is the best way to quickly contact family or friends in case of an emergency and facilitates emotional connection (Cao et al. 2010), the asynchronous communication method is considered more flexible and, more often, is what elders prefer to use since they have the possibility to reply to the messages they receive on their own time and without making them feel obligated to answer right away. Thus, it was possible to observe that while two systems offered a way to communicate synchronously, nine offered asynchronous communication and three offered both which is the best option.

That said, most systems relied on communication through a digital channel and few tried to incorporate methods to set a meeting where the users could interact in the same space. Only seven systems had the function to plan an activity, encouraging them to leave their home and comfort. The applications that recommended activities or events to the users can be considered successful since a significant percentage of the elderly were satisfied with the recommendations they received and that allowed them to interact with other people.

In these cases, it was very important to be aware of the user's interests so that the recommendations could be successful. Only the *FridgeNet*'s service to invite people to go shopping wasn't used very often since users preferred to do the activity with people they felt comfortable with, not people with similar nutritional requirements that the system recommended.

Every system was analysed in terms of usability and accessibility receiving positive feedback, with some corrections pointed out. The systems that performed tests with users, felt that they were successful in improving social connectedness between the elderly and their social network but still need to perform more tests in the future to guarantee more solid results.

# Chapter 3

# PersonALL

## 3.1 Overview

PersonAAL is a project that aims to improve and extend the time elderly people can live independently in their home environment by assisting them in their daily life and making them less dependable of family members and caregivers, thus improving quality of life and decreasing healthcare delivery cost. To achieve this goal, it provides intuitive web applications enabling them to receive personalized and context-dependent assistance and incorporates personalization technology to match solutions with the user's needs and capabilities.

Taking an already established web application for the elderly, by accessing the PersonAAL platform, the application will also be capable of sending personalized reminders according to specific needs and adapt its user interface to the abilities and surroundings of the user.

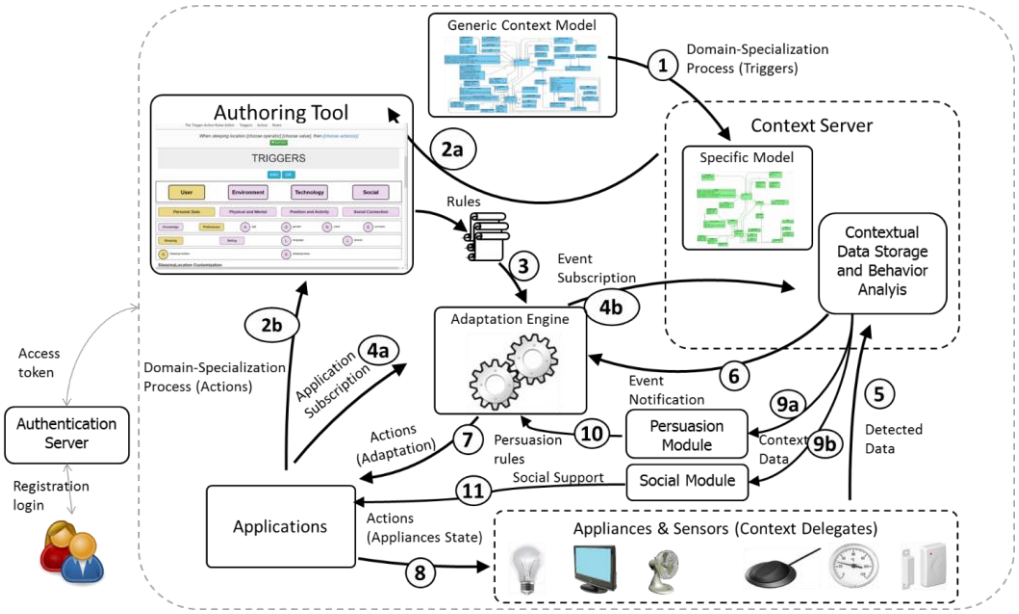


*Figure 1 – The PersonAAL architecture and information flow*

## 3.2 Architecture and Components

The PersonAAL's architecture is presented in Figure 1. The following sections describe its components.

### 3.2.1 Authentication Server

Being the safety and privacy of the users' data of the utmost importance, the *Authentication Server* provides the main security and data protection mechanisms to all components and web applications. It protects information collected within the platform against unauthorized access, ensures date confidentiality and integrity making authentication necessary before any exchange of data between components.

The server is based on the *OAuth 2.0* protocol implementation that authenticates all components within the system and is hosted on a professional and secure hosting platform that provides uninterrupted and continuous operation and access.

### 3.2.2 Context Manager

The *Context Manager* is the module that gathers, stores and manages contextual data associated with each user and communicates it to other components in a more logical structure. It is composed by a server and several delegates installed in various devices that collect data and pass it to said server. The data can be gathered from sensors (physical activity, weight, temperature, noise, light, etc.) or external services (user information gathered from other applications, i.e. *Remote Assistant*).

### 3.2.3 Authoring Tool

The *Authoring Tool*, or *Rule Editor*, is a web environment where the elderly or their caregivers can create, delete and edit rules which will then be sent to the *Adaptation Engine*, providing a way to personalize the applications and the persuasion mechanisms.

The rules are created by selecting triggers and the respective actions and use an Event-Condition-Action format where events are changes of context states, the condition (optional) are Booleans referring to the context state and actions are changes in the applications or the activation of some functionalities.

To save and delete rules, the *Authoring Tool* uses REST Services, so when a rule is saved its XML description is sent via HTTPS POST to the *Adaptation Engine*.

### 3.2.4 Adaptation Engine

It's the *Adaptation Engine'*s responsibility to check if the rules created with the *Authoring Tool* or the *Persuasion Module* meet the conditions to be triggered and if those conditions are met, to trigger the rules.

To do so, it communicates with *Context Manager* to check if the values stored are able to meet the rules condition's and when the rules are triggered, it's the *Adaptation Engine* that communicates with the applications and notify that actions must be executed, not executing the action itself.

These actions can take multiple forms from sending persuasive notifications, reminders and alarms to the user or execute other effects like turning on/off the lights in the user's home.

### 3.2.5 Persuasion Module

The initial version of the *Persuasion Module* was developed in the scope of the PIQL project (*Persuasive Interfaces for Healthier Quality of Life)* (Silva, 2017). Its main goal is the creation of persuasive messages to reinforce the user's positive behaviours and change the negative ones.

The system consists of five modules:

- *IdentifyPatterns*: This initial module is responsible for the user's activity patterns identification.
- *DeviationPatterns*: Receives information from the *Context Manager* regarding the user activity patterns and is used to detect deviations in those patterns.
- *COMB*: Is related with the behaviour model chosen for the system (COM-B) and is responsible for identifying factors that explain the user's behaviour, namely deviations to patterns.
- *BCTSelection*: Chooses which persuasion techniques will be applied to the user.
- *BCTInstance:* The last module receives the factor and persuasive techniques from the previous modules and builds the persuasive messages that will be sent to the user.

Also, a MySQL database is used to store states and results generated by the PIQL system.

## 3.3 Applications

In the scope of the PersonALL project, three applications were developed to demonstrate the support and operation of the project's framework.

### 3.3.1 Medication Monitor

The *Medication Monitor*'s (Figure 2) main goal is to provide elderly patients and respective caregivers with support in the management of elderly's medication intake.

This application seeks to improve medical adherence thus preventing complications and other medication related risks such as medication overdose or forgetting to take them. With a simple interface, the patient can specify his medication plan selecting the time frame (the first and last day to take the medicine), the days of the week, the notification time and the medication list.

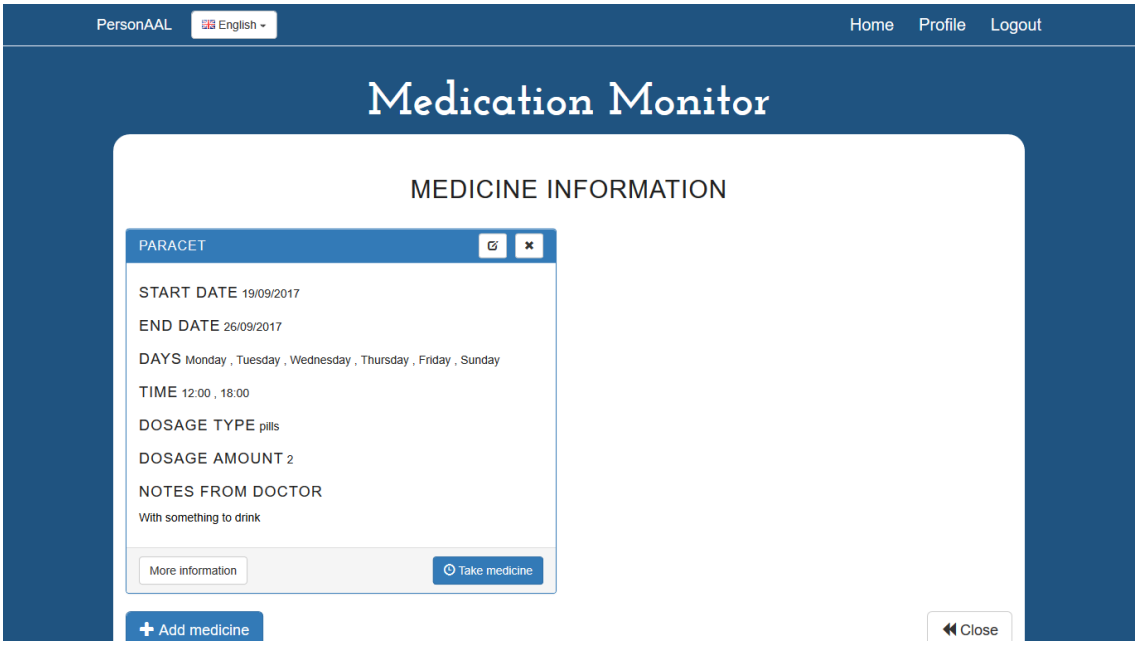


*Figure 2 – Medication Monitor application*

### 3.3.2 Activity Tracker

The *Activity Tracker* application aims to maintain or increase the user's level of physical exercise and physical activity by offering personalised activities and exercise programs.

Using a similar interface (Figure 3) to the *Medication Monitor* the user can establish an activity plan by selecting the time frame for each activity, the days of the week and the time it should begin. Besides adding a name to the activity, choosing its

intensity (which can be *moderate* or *high*) and its duration, the user must choose between eight different types of activities:

1. *Household chores (gardening/home);*
2. *Walking*;
3. *Cycling*;
4. *Swimming*;
5. *Dancing/moving to music*;
6. *Running*;
7. *Strength training*;
8. *Other physical activity*.

If the user chooses the option *Strength Training*, he can then choose between different exercises from a list of available exercises which also offer a related image, a brief explanation and a workout plan.


*Figure 3 – Activity Tracker application*

### 3.3.3 Remote Assistant

The *Remote Assistant* is a web application which aims to assist the user in various aspects of his daily life such as health, fitness, medication, activities plan and home ambient. By collecting physiological parameters trough sensors (heart rate, weight, respiration rate, etc.) that data is evaluated for potential problems (a fall or high heart rate) so that caregivers can be alerted if such problems occur.

The application is composed by five pages (*Home, Health, Plan, Profile, Contact*) and during this project, besides other changes that will be explained in the next sections, another page was added (*Hue Lights*).

- *Home* page: In this page (Figure 4), a dashboard is presented with the summary of the user's physical parameters such as weight, BMI, heart rate, respiration rate, temperature rate, internal temperature as well the user's progression in terms of his exercise time and step count goals and at last a medication diary reporting his planned medication. It also presents a survey to collect more information about the user like his weight, height, age, motivational preferences and some questions directed to provide a self-assessment of the user's fitness;
- *Health* page: This page shows graphs of user's physical attributes like the weight;
- *Plan* page: This page allows the user to plan his weekly goals, schedule activities for the week and report his progress. This page is a big part of this thesis' focus, so its components will be further explained in the next sections;
- *Profile* page: The page where the user can modify personal data inserted during registration and add interests;
- *Contacts* page: In this page the user can add personal contacts and visualize their current status (*online* or *offline*);

- *Hue Lights* page: This page allows the user to control the lights inside his apartment in its intensity and colour.

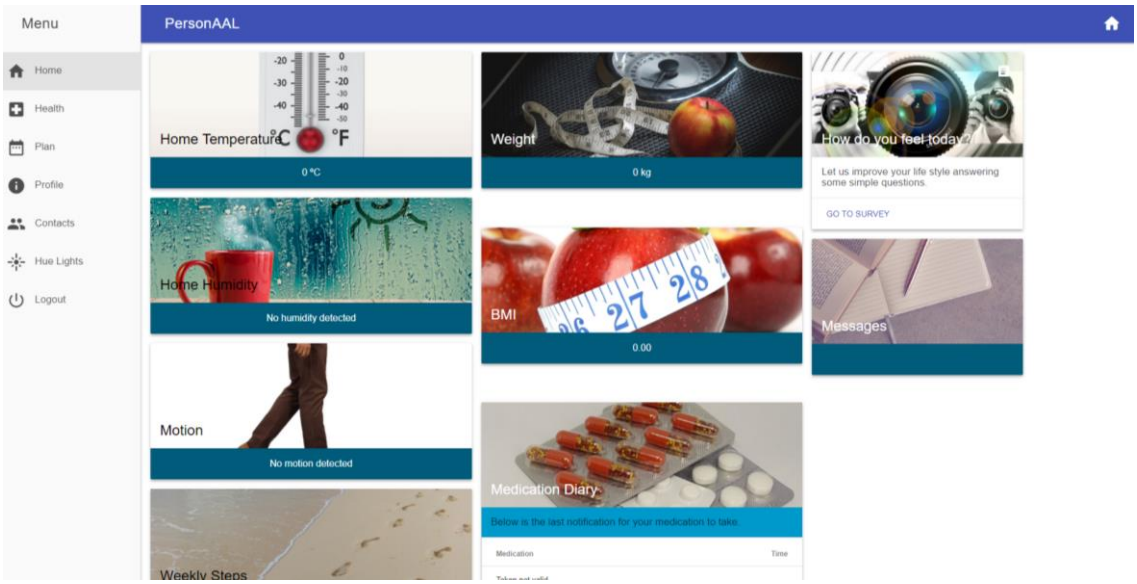


*Figure 4 – Home page of the Remote Assistant Application*

### 3.3.4 Notification Application

All the notifications are sent through a push from the *Adaptation Engine* and are visible when the user accesses the application that triggered the notification. In order for the user receive the notifications from the different applications without having to access each one to see them, a mobile application was developed. The *Notification Application* besides allowing the user to receive the notifications from *Medication*

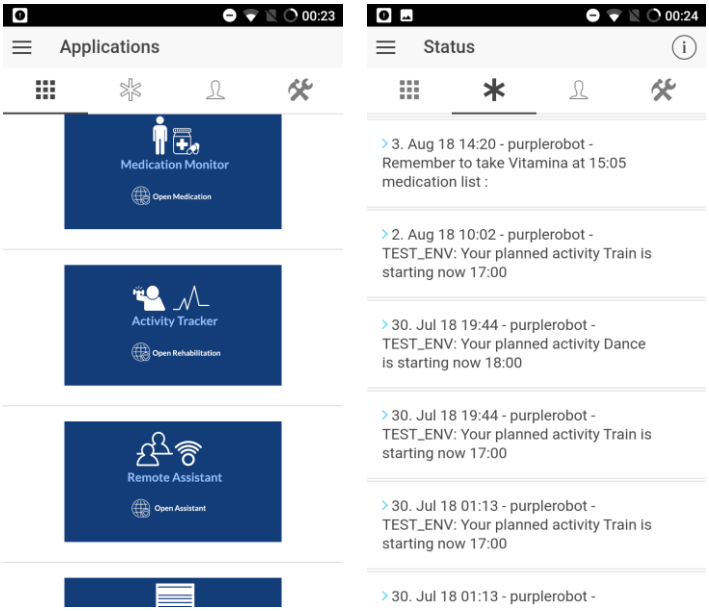


*Figure 5 – Notification application home screen (left) and notification screen (right)*

*Monitor*, *Activity Tracker* and *Remote Assistant* applications (Figure 5, right), also facilitates the access to said applications plus the *Rules Editor* (Figure 5, left).

## 3.4 Discussion

Both the *Remote Assistant* application and the *Persuasion Module* were not yet fully prepared to meet the goal of using persuasive methods to engage the user in more physical and social activities.

One of the first aspects lacking is how can more information regarding the user's social activity be collected. Besides information given by the user in the application, more specifically in the calendar when planning social outings, other forms of retrieving information must be explored.

The *Remote Assistant* application provided only a few options to be able to engage the user in social activities. It was necessary to find ways to improve the application by building a more extensive set of features.

As only modifying the *Remote Assistant* would not offer guarantees in improving the user's social activity, it was also necessary to modify the *Persuasion Module* application so that the persuasive methods implemented would reflect the changes made in the *Remote Assistant* application, meeting some of this thesis' goals.

# Chapter 4

# Purple Robot

As explained in previous sections, one important aspect of this project was exploring ways to retrieve information regarding the user's social activity. After searching for literature that used methods of retrieving various types user's information via sensors (Saeb & Zhang, 2015), the application *Purple Robot* was selected.

## 4.1 Overview

The *Purple Robot* (Figure 6) application for Android devices was developed by the *Center for Behavioural Intervention Technologies* at Northwestern University and is available at the Google Play store for download[2].

It is a sensing and scripting application that enables the creation of context-aware experiences. It includes a full on-device sensor suite as well as embedded scripting environment exposed via an HTTP API that allows other apps full access to the sensor and trigger functionality.

As a full real-time sensor data acquisition platform for collecting information regarding its users and their surroundings, *Purple Robot* provides full access to the Android sensor framework, device information and location sensors, options to scan for external devices and statistical summaries of the user's communication patterns.

[2] https://play.google.com/store/apps/details?id=edu.northwestern.cbits.purple_robot_manager&hl=pt

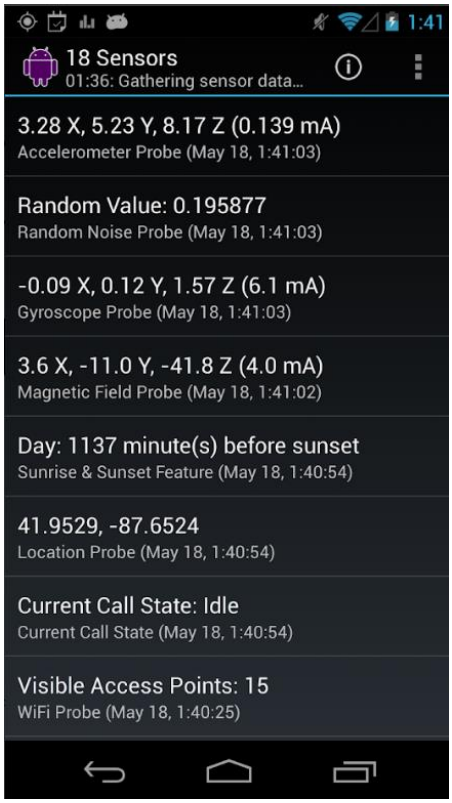


*Figure 6 – Purple Robot application*[3]

## 4.2 Configuration

Given the theme and purpose of this thesis, it was necessary to decide which sensors would offer relevant information. *Purple Robot* offers a large quantity of probes separated in various categories. Since the focus was to monitor social activity, the enabled probes would have to give information regarding the user's interactions with external factors.

**Calls and message logs**

A direct way to monitor the amount of social interaction one has is by examining phone call and direct messages' logs. *Purple Robot* has access to those logs in the user's phone, allowing to know when the call/message took place by enabling the *Communication Events Probe* in the *Personal Information Probes* category.

**Wi-Fi and Bluetooth**

By listing the Wi-Fi networks and Bluetooth devices in the user's surroundings, it would be possible to establish some semblance of social activity pattern. By associating

[3] Screenshot of the Purple Robot application accessed 20 November, 2018, https://play.google.com/store/apps/details?id=edu.northwestern.cbits.purple_robot_manager&hl=pt .

Bluetooth devices to people, it could be detected who the user is meeting with and when. The same logic would apply in associating Wi-Fi networks to certain places or people. In the *External Device Probes* category, the *Visible Bluetooth Probe* gives information regarding the Bluetooth Address of the devices in range, the time when they are being detected and if the device is paired with the user's device. In the same category, the *Wi-Fi Probe* gives information regarding the network's capabilities, level, frequency, BSSID, SSID, time that is being detected and the number of detected access points.

**Applications used**

Aside from face to face conversations, phone calls and text messages used to be the main form of communication, but nowadays one can communicate without resorting to them. Facebook, Messenger, WhatsApp, Skype, Twitter, Instagram and other forms of social media and communication apps allow users to get in contact with their acquaintances. Knowing which applications the user has installed in his device and when they are used can also be a way to detect social activity.

**Location**

Finally, knowing the user's location, while not giving any knowledge regarding social activity, allows to know where the user is spending his time. By accessing his location, it is possible to check if the user leaves his house regularly or if he frequents places where social activity can occur like restaurants, cinema, church, etc.

## SERVER CONFIGURATION

To receive the data collected by the various probes, it was necessary to enable and configure the data upload endpoint in the *Purple Robot* application. To do so, the endpoint *http://accessible-serv.lasige.di.fc.ul.pt:9080* had to be specified in the general data upload settings. In this endpoint a server was needed to collect the data sent by the Purple Robot application.

The *Purple Robot* documentation provided a small start server (server.py) written in Cherry.py (a minimalist python web framework) that saves JSON payloads to files on a local server. The application once connected to the internet and pointed to a server, would start to upload the data collected or the user had the option to manually select the option to *start uploading data.*

The data sent from the probes is stored in a JSON file identified by its timestamp with the following fields:

- *UserHash*: MD5 hash of the user identifier previously set int the application's settings, which defaults to the user's Google account if not specified.
- *Operation*: is always "SubmitProbes".
- *ContentLength*: the content's length.
- *Payload*: contains an escaped string representing a JSON array containing the sensor data.
- *Checksum*: contains an MD5 hash of the concatenation of the UserHash, Operation and Payload key.

## 4.3 *personaal_social* database

In its initial state, the *Purple Robot* server would create a folder *Files* and send the JSON files to that location. However, it was also necessary to parse all the relevant information in the files and store it somewhere.

To do so, a MySQL database was implemented with the following tables:

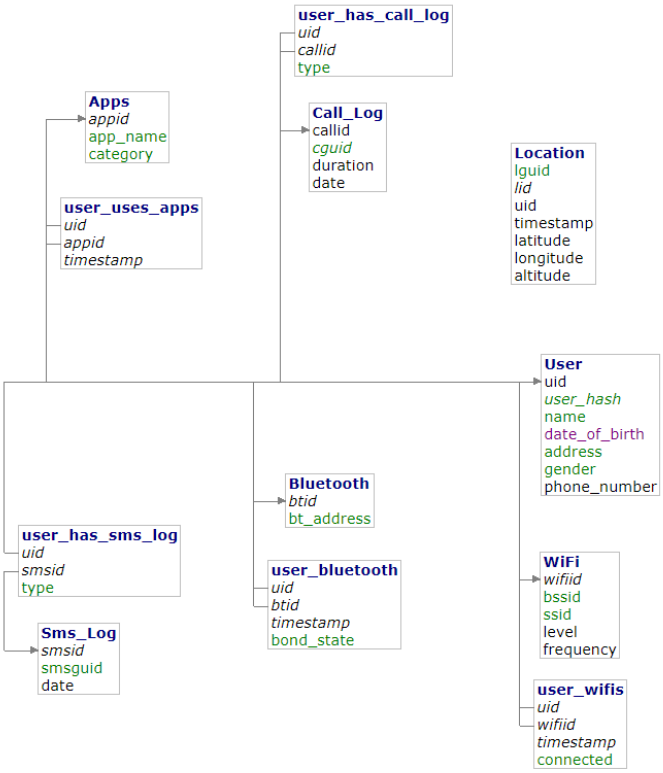


*Figure 7 – personaal_social database schema. Type text fields are green, dates are purple and the remainder are ints or varchars*

- *User:* has an auto-increment *uid* and a varchar *user_hash* taken from the JSON file. Other fields that were added but ultimately not used were *name, date_of_birth, address, gender, phone_number.*
- *Apps*: has an auto-increment *appid and* stores the *app_name* and *category* of the applications used in the device.
- *user_uses_apps:* with foreign keys to the *User* and *Apps* tables, stores the *uid*, the *appid* and the timestamp of when that application is being accessed by the user.
- *Bluetooth:* has an auto-increment *btid* and stores the *bt_address* of all the devices in the user's surroundings.
- *user_bluetooth:* with foreign keys to the *User* and *Bluetooth* tables, stores the *uid, btid,* the *timestamp* of when the user's device detects the Bluetooth device and the *bond_state* (if it is paired).
- *WiFi:* has an auto-increment *wifiid* and stores the *bssid, ssid, level* and *frequency* of the various wireless access points around the user.
- *user_wifis:* with foreign keys to the *User* and *Wifi* tables, stores the *uid, wifiid*, the *timestamp* of when the user's device detects the wireless point and if the device is *connected* to it.
- *Call_Log:* besides having an automatic incremented ID, also stores a unique identifier (*cguid*) generated by *Purple Robot*, as well as a duration and date of the various calls the user has made.
- *user_has_call_log:* with foreign keys to the *User* and *Call_Log* tables, stores the *uid, called* and the call's *type* (incoming or outgoing).
- *Sms_Log:* has an automatic incremented ID and stores the unique identifier (smsguid) and the date the message was sent/received.
- *user_has_sms_log:* with foreign keys to the *User* and *Sms_Log*, stores the *uid, smsid* and the messages' *type* (*incoming* or *outgoing*).
- *Location*: has an automatic increment *lid,* the user identifier *uid,* an identifier *lguid* provided by the purple robot, a *timestamp, latitude, longitude* and *altitude.*

With the database ready, some changes were made in the *server.py* file so that, besides creating the log files and sending them to the specified endpoint, it would also fill the database directly.

To make the required changes in the *server.py* file, the development environment used was Eclipse version neon.3 with the *PyDev* plugin.

First it was necessary to configure the server socket port to *9080* and the server socket host to *'accessible-serv.lasige.di.fc.ul.pt'*. Second, to check if the user already exists in the database and, if not, to create a new entry in the *User* table with the *UserHash* field from the file.

Then, the server checks if the field *Probe* equals one of the following values for each payload:

- *WifiAccessPointsProbe;*
- *LocationProbe;*
- *BluetoothDevicesProbe;*
- *ApplicationLaunchProbe;*
- *CommunicationEventProbe.*

If so, the values are checked for duplicates and then inserted into the corresponding tables in the database.

## 4.4 Discussion

In summary, to be able to use the *Purple Robot* in the context of this project, first were activated the probes that would return relevant data like the calls and message logs, location, applications used, Wi-Fi networks and Bluetooth devices. Then a database had to be created to store the information retrieved from the probes. At last the server had to modified so that the *Purple Robot* could upload the data directly into the database.

Unfortunately, it was not possible to use in the PersonAAL project this method of collecting information largely due to the high level of sensitive information that would be retrieved and the concerns regarding the data's privacy and safety.

To upload the data collected by the sensors to the server, *Purple Robot* uses an HTTP connection, which was considered to be a high security risk. Additionally, the coming into force of the *EU General Data Protection Regulation* during the lifetime of

the project, and with the different implementations of the regulation in the different countries involved, raised obstacles that were not overcome during the project.

# Chapter 5

# Design

This chapter explains the requirements for the *Remote Assistant* application and Persuasion Module and describes the proposed design to meet such requirements.

## 5.1 Persuasion Module

The *Persuasion Module*, used to create persuasive messages according to the user's physical activities, needed to be modified so that the level of complexity regarding the persuasive techniques could increase. When adding the social component and the new information that could be accessed from the *Remote Assistant* application it was necessary to create new persuasion methods (rules) that could be applied to the user. Although the focus of this thesis lies heavily on the social domain, it was also important to not disregard the physical aspect and continue to improve the *Persuasion Module* in both ways.

In collaboration with the psychology partners in Norway, one of the first aspects discussed in the meetings regarding persuasive methods was the need for the user to be in charge of setting his own goals in terms of physical and social activity and that the persuasion should focus on helping the user reach his set goals. Once the user was able to reach those goals on his own, he would be more prone to set them higher in the future. Besides informing the user of his progress and congratulating when his goals are reached, it was also important to create rules that can lead the user to plan more activities, either physical or social.

In collaboration with the partners, a set of rules was created with the goal of persuading the user to be more physically and socially active. In creating these rules, it

was important to focus on positive reinforcement to maintain the user motivated and encouraged by his progress.

Each rule is structured as follows:

- *Domain:* If the rule is related to physical activity, social activity or specific to an application (for the rules created, the only specific application was the *Remote Assistant*);
- *Name:* The name of the rule;
- *Conditions:* Which conditions must be met to trigger the rule;
- *Trigger:* When the rule will be triggered (can be a specific day or time).
- *Message:* Each rule can have associated multiple messages with different types, as will be explained further in this section, where one will be selected randomly to create the final message. The message is also translated in three different languages (English, German and Norwegian) so that depending on the user's language, the correct translation is presented.

In the end, twenty-three rules were created, whose main purposes were to:

- Remind the user of his planned activities for the day;
- Suggest the user to invite someone to some activities;
- Inform the user of his fitness activity;
- Congratulate the user when his fitness activity increases;
- Encourage the user to reach the goals he set up in the Remote Assistant application;
- Inform the user of his progress regarding his goals.

The rules' generated messages can be of three types:

- Rational: Convey information to the user regarding his activities;
- Motivational: Congratulatory messages regarding the user's progress;
- Social: Suggestions for some sort of social component in the user's activity.

Besides being divided in these three types (rational, motivational and social), the messages can also be separated in two categories: the ones that simply convey to the user a standard message or a personalized message with some of the user's personal

information. It was important to be able to offer the user different types of messages, keeping the user from getting bored by receiving constantly the same content.

All the rules created can be found in the Appendix A, but a couple of examples showing the different types of rules and messages are now presented:

**Rule 1: More steps than typical day**

*Conditions*: if the user's number of average steps from the previous day is higher than the average number of steps from the last 7 days.

*Trigger*: Every day at 08h00 in the morning

*Message 1*: Yesterday you walked X more steps than a typical day. (Rational)

*Message 2*: Hurray! Yesterday your step count was great! (Motivational)

**Rule 2: Invite to Exercise**

*Conditions*: The user has planned a *Walk* type activity in the Remote Assistant application for the current day and has not set that activity has complete yet.

*Trigger*: Every day at 12h00.

*Message 1*: What about inviting someone for a walk today? (Social)

The data used in the rules to trigger events can come from multiple sources. Information like the user's complete activities, goals and *Fitbit Daily Summary* is available in the *Context Manager*. However, since some of the rules deal with data that will not be sent to the *Context Manager* like the planned activities the user created with the *Remote Assistant*'s calendar, that information will also need to be accessed, so it can be processed in the same manner as the others. The chosen method will be further explained in chapter 6 (Implementation) section 6.2.7 (REST service for planned activities).

## 5.2 Remote Assistant

The Remote Assistant application, as previously explained, is a web application directed at helping the user throughout multiple functionalities where its six pages (*Home, Health, Plan, Profile, Contact* and *Hue Lights)* centers in a specific aspect of the user's daily life.

In order to be able to access the data inserted by the user in the application and consequently use it when improving the *Persuasion Module*, one of the first requirements was to send all the relevant information that was still missing to the *Context Manager*, which will be further explained in chapter 6 (Implementation):

- *Meet goal*: the user's weekly social goal;
- *Exercise goal*: the user's weekly exercise goal;
- *Walk goal*: the user's weekly walk goal;
- *Completed activities*: information regarding the activities the user completed;
- *Contacts information*: information inserted in the *Contacts* page by the user;
- *Profile information:* information inserted in the *Profile* page by the user.

### 5.2.1 Home Page

In a first approach, cards such as the user's weekly progress in terms of step goals and exercise goals were to be removed from the *Home* page and a new card with the user's weekly steps should be made available to the user. These changes relate to other modifications regarding the goals in the *Plan* page, that will be explained in the section 5.2.5.

### 5.2.2 Profile Page

The main change required for the *Profile* page was allowing the user to edit his profile information.

### 5.2.3 Contacts Page

In the contacts page, when adding a new contact to the contact's list, the user would insert the contact's name, email and phone number. However, in order to build social rules that could explore the type of relationship the user has with his contacts it was necessary for the user to also include that information. The options would be:

- *Close family;*
- *Other family,*
- *Friend;*
- *Neighbour*.

The user could select more than one option since there can be overlaps.

### 5.2.4 Health Page

The *Health* page had to display the following information previously shown in the *Home* page to thematically keep all health-related information in the *Health* page. Furthermore, in the initial version, the information displayed in the *Health* page was received directly from a *Bitalino* sensing device connected to the device when the user was consulting the *Remote Assistant* application. The following data now had to be accessed from the *Context Manager* through a REST service:

- Heart Rate;
- Respiration Rate;
- Internal Temperature;
- Weight;
- BMI.

The following boxes had to be removed:

- Score Chart;
- Accelerometer chart.

### 5.2.5 Plan Page

Initially, as can be seen in Figure 8, the card *Set Weekly Goals*, where the user would set his goals for the week by choosing between three options for the three types of activities, made use of radio buttons. In the *exercise* activity, the user was given the choice between 15, 30 or 60 minutes; In the *walk* activity, the user could choose between 5000, 10000 or 20000 steps; in the *meet* activity the user had the option of meeting *at least 3, at least 5* or *more than 5 persons*.

The first change thought for this card was replacing the *meet* goal with the number of social activities the user would set out to do that week. Instead of focusing on the number of people the user would meet, it was considered by the psychology partners more important the number of social outings the user would participate in. This is due to the fact that, besides being more natural counting social activities than the number of people one is going to spend time with, the most important aspect to improve should be trying to increase the number of times the user interacts socially with someone.

Next, the *exercise* goal and *walk* goal had to change from minutes (in case of *exercise*) and steps (in case of *walk*), to hours. It was considered more practical and easier for the user to express his exercise goals in hours than in minutes and that it is

very difficult for someone to have a clear idea of how many steps they plan to take since not everyone has the notion of how many steps one walks during the day.

At last, it was considered, in collaboration with the psychology partners in Norway, that only giving the user 3 options to choose from in the different types of activities was very limited and that there should be a bigger range of options.

Consequently, the card *Show Weekly Goals* needed to be modified to reflect the changes made in the *Set Weekly Goals* card. The *exercise* and *walk* progress from minutes and steps to hours and the *meet* progress to *social activities.*

The calendar initially implemented in the *Remote Assistant* had three fixed activities (*exercise*, *walk* and *meet*) that the user could drag to the chosen day of the week. Depending on the type of activity, once dragged to a certain day, the user could specify the activities' intensity. If the type was *Walk*, the user could choose the number of steps they would walk during the activity through a menu with fixed values; if the type was *Exercise* the user could choose the duration of the exercise (in minutes) also through a menu with fixed values; if the type was *meet* the user could choose the number of people he would meet during the activity.

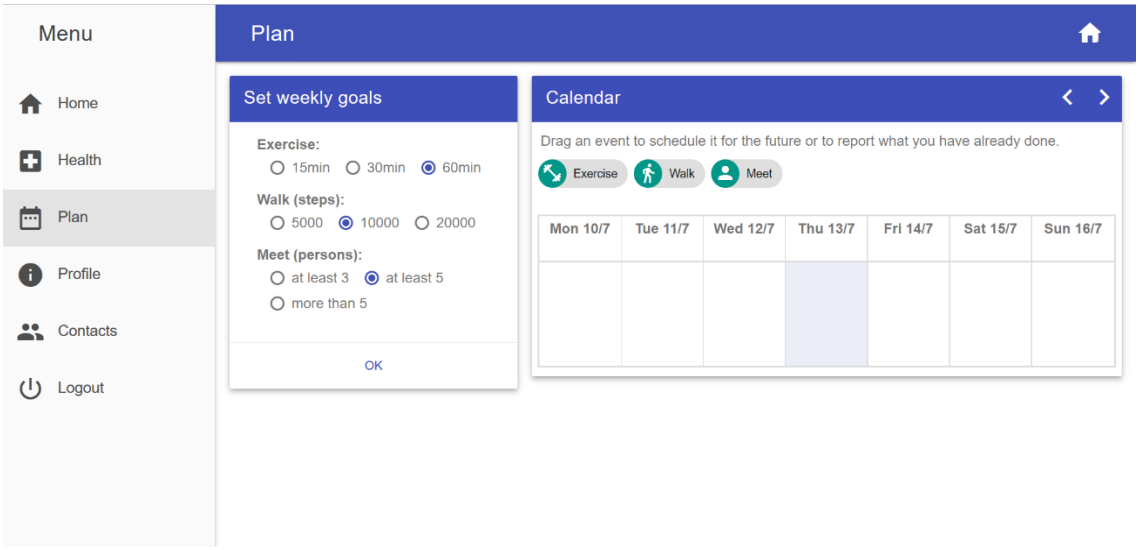


*Figure 8 – Original plan page of the Remote Assistant application*

One of the main limitations of this calendar was the lack of a start and finish time for each of the activities created. The user could only specify the day the activity would occur not knowing after at which time it would start and finish. Another aspect that

could be improved was for the different types of activities to have different colours, making it easier to distinguish once they are added to the calendar.

The main focus of the *Plan* page was then to implement a calendar where the user could add activities, which would be presented in different colours according to its type and choose the date and time for its beginning and end.

This new calendar would have to be incorporated in the already existing page and in its proper place next to the weekly goals card. Since the application can be used in a web browser, tablet or smartphone, its design would have to be responsive to easily adapt to all kinds of screens and easy to navigate so that the users would not need to have a long adaptation period.

As the week is a predominant aspect of the page, ideally the calendar should have a weekly view, but it would also be appreciated if it could display a monthly view and a daily view. Next by clicking in a specific day in the calendar a menu should appear where the user would select first the start and end times, then the type of activity and at last the intensity of said activity.

Inside the calendar, the most important aspect is how the user would be able to create an activity. Since the application is directed to the elderly, every component of the menu responsible to create the activity needed to be carefully planned, from the type of menus to the time picker.

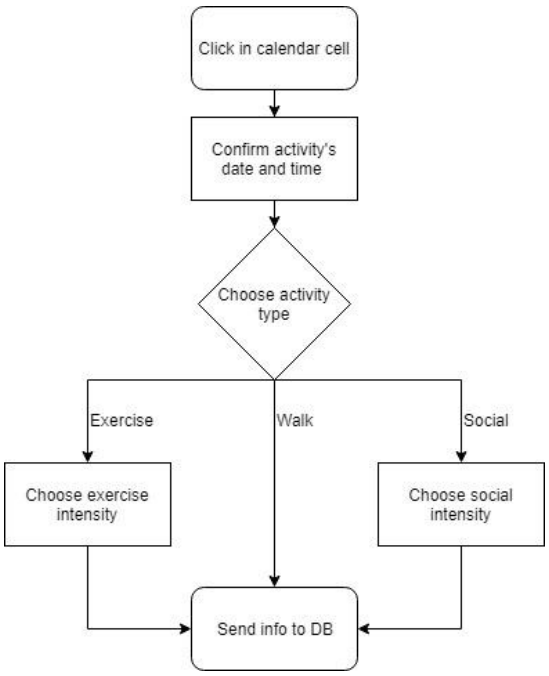


*Figure 9 – Process of creating a new activity in the Remote Assistant application*

For simplicity and to not overwhelm the user with a lot of information at once, the card to create an activity should have the different steps appearing as the user completes them. By clicking in a calendar cell, a card would appear where the user can confirm or change the start and end times. Next the user should specify which type of activity he wants to create and is given the three options already mentioned. The last step would be regarding the activities' intensity where depending of the option chosen in the previous step, it would show different options for the user to choose as can be illustrated in Figure 9 and will be further explained in chapter 6 (Implemetation).

For choosing the activities' start and end times, several time pickers were considered. The easiest to implement would be to simply have two boxes where the user could insert or increment the values associated to hours and minutes. Several plugins were analysed, like the *Material-Ui Pickers*[4], the *Wickedpicker*[5], *Material Datetime Picker*[6] amongst others. In the end and given the target audience, the one selected should require the least number of clicks and steps as well as have an interface that most resembled an actual clock (something the users would already be familiarized with).

The initial calendar allowed the user to click on the activities already added to the calendar where a card would appear with information related to the activity in question (the date and the intensity), giving the user the options to remove the event or to mark it as complete.

This posed a problem, where it falls on the user to go through the calendar and click on all the activities to mark them as complete. To make the process simpler and not depend on the user's ability to remember to do so, it would be best to show the user his past activities not yet marked as completed, as soon as the user enters the *Plan* page and ask if those activities have been completed meanwhile.

At last, given the fact that the user can also plan activities in another application (*Activity Tracker*), showing those activities in the *Remote Assistant* calendar would help the user avoiding constantly switching between application to know his complete activity plan. Also, the *Activity Tracker* shows the user's planned activities in form of a

[4] https://material-ui.com/demos/pickers/
[5] http://ericjgagnon.github.io/wickedpicker/
[6] https://github.com/ripjar/material-datetime-picker

grid with cards displaying relevant information, and it would be helpful for the user to also see them in a calendar view to have a better overview of the dates.

# Chapter 6

# Implementation

This chapter explains how the changes mentioned in the *Design* chapter were implemented in the *Persuasion Module* and the *Remote Assistant* application.

## 6.1 Persuasion Module

In this thesis the focus was only on the three final modules: *COMBFinal*, *BCTSelectionFinal* and *BCTInstanceFinal* since it was not necessary to make any changes to the first two modules (*IdentifyPatternsFinal* and *DeviationPatternsFinal*).

In the *Persuasion Module'*s earlier version (Silva, 2017), physical activity patterns were identified on physical activity collected every fifteen minutes. However, in the deployed *PersonAAL* framework, the data regarding physical activity comes from the *Fitbit Daily Summary* stored in the *Context Manager* which means the existing solution could not be used since there is only a summary of the user's activity for the day available, instead of fifteen-minute increments.

The pattern deviations that were being detected were also used as triggers. In the new version this could not be used, so the module *COMBFinal* was made the initial processing module in the *Persuasion Module*.

### 6.1.1 Tools used

The Eclipse Neon.3 version was once again chosen as the development environment, Java as the programming language with the Java Development Kit (JDK) version 1.8.

### 6.1.2 Rule Processings

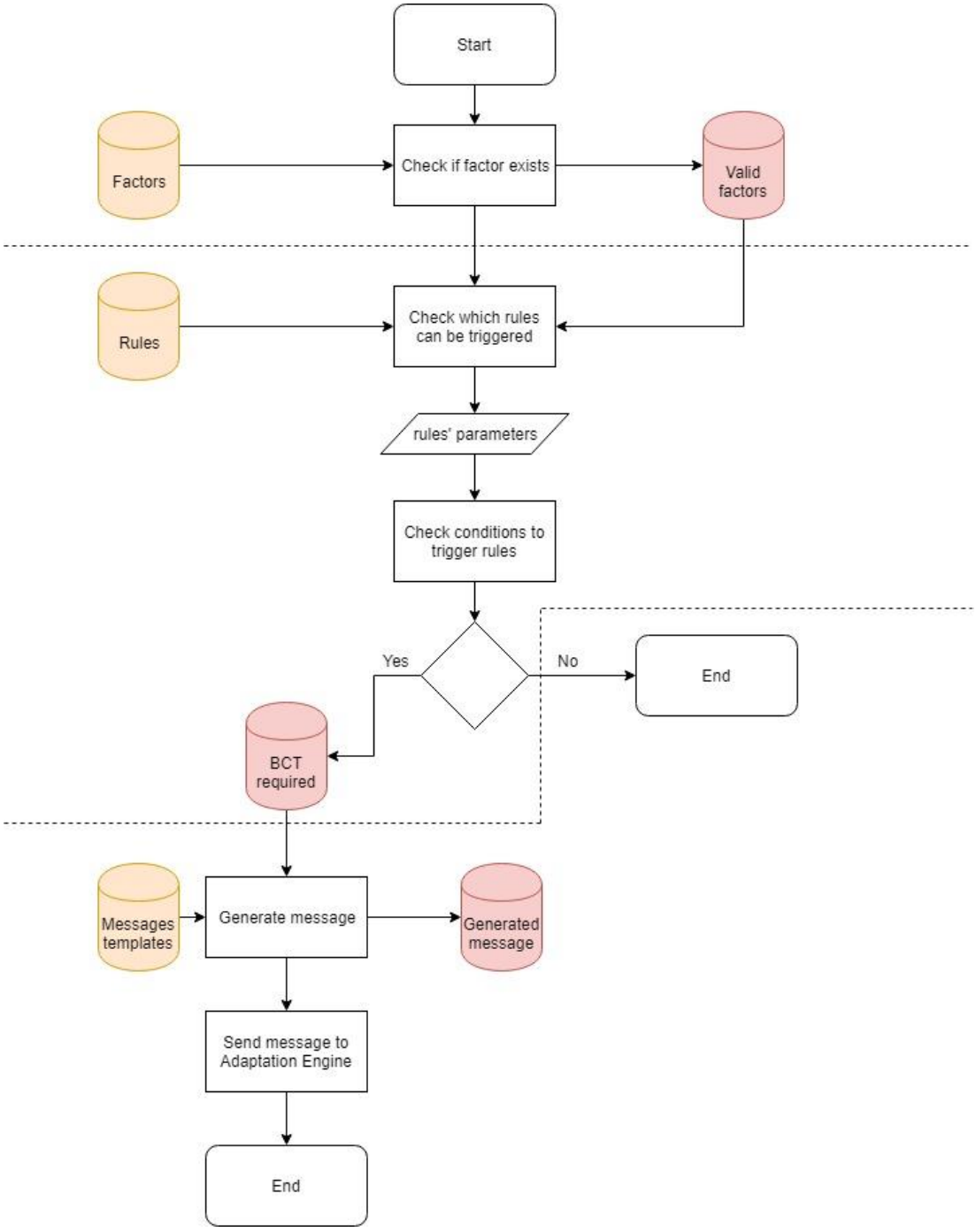


*Figure 10 – How a rule is processed in the Persuasion Module*

To be able to process a rule, as illustrated in Figure 10, the first step is to check if the factor associated with that rule exists and is valid. A factor is what will be associated with the rule during the entire process and can be associated with various parameters which, in turn, have an URL that can be accessed to retrieve values. For example,

*FitBitActivityHistory* is a factor that will be associated with parameters whose values come from the *Fitbit Daily Summary.*

This first section in the Figure 10 (equivalent to the module *COMBFinal*) only has to verify that all the URLs associated with a factor are valid, i.e. that it is possible to access said URL. If that is the case, then the factor is stored in the database, to be used in the next step.

Once that process is complete, the next section (*BCTSelectionFinal*), takes the valid factors and retrieves the rules associated with those factors. The following step is to check if conditions are met so that those rules can be triggered.

First, each rule can only be triggered at a specific day of the week and specific hour. If the *Persuasion Module* is not being executed at the time and date associated with the rule, then the rule cannot be triggered. If the time and date are correct, then the URLs associated to the valid factors are accessed and its values retrieved to be used in the rules.

Each of the rules created in natural language is going to be associated with the respective rule file that receives the values previously retrieved from the URLs and checks if the rule's conditions can be triggered. Each rule is also associated with a *BCT (Behaviour Change Techniques),* used as an identifier for the various messages, that is stored in the database in case the rule is triggered.

Finally, the last section is associated with the final module (*BCTInstanceFinal*) and will deal with generating all the messages associated with the rules triggered in the previous module. These messages, that can be generic or personalized, are created using the templates available in the database and are accessed by the message identifier, the *BCT* previously stored. Once that message is created, it will then be merged with all the other messages from the different rules triggered for the user. That final message will then be stored in the database and sent to the *Adaptation Engine.*

### 6.1.3 Database

The persuasion module database was already implemented as a part of the master's thesis previously mentioned (Silva, 2017), since it was necessary to store states and results generated by the PIQL system (Figure 11).

As mentioned above, since the two first modules were not used in this version, the tables directly associated with it were not used and no changes were necessary. The tables not used in this version are:

- *StepCount;*
- *Deviation;*
- *Pattern;*
- *DecisionTree;*

In the table *Deviation* however, to be able to start the *Persuasion Module*'s execution with the third module (*COMBFinal*), the users auth0 had to be inserted manually in that table, since the system was prepared to only be able to continue to the next module if activity pattern deviations were detected for the user.

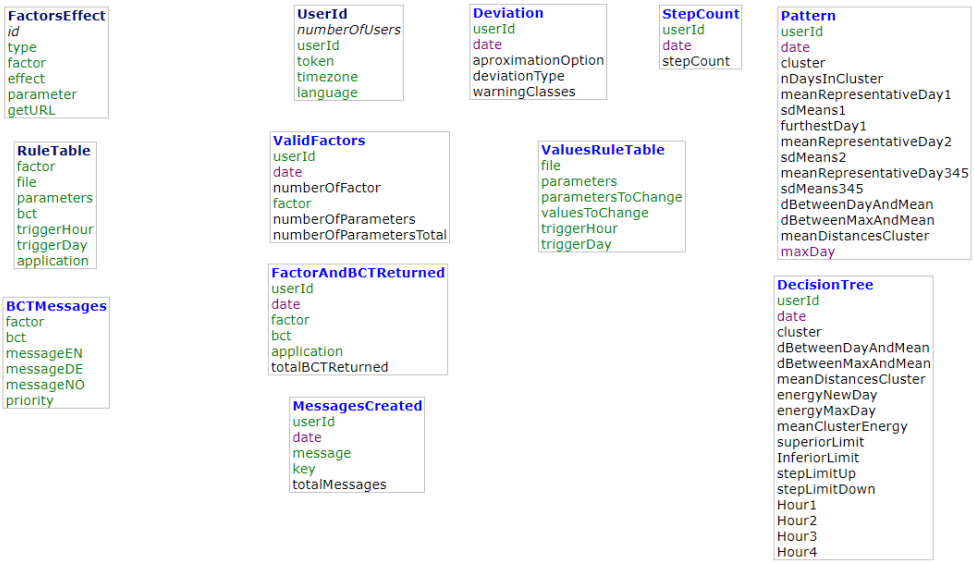


*Figure 11 – personaal database schema*

The next paragraphs present the tables that were used and the modifications that were necessary:

**FactorsEffect Table**

This table is used in the module *COMBFinal* and contains the following fields:

- *id*: an auto-increment number;
- *type*: the type of factor;
- *factor*: is associated with which type of parameters are necessary for a specific rule.
- *effect*: the effect on the user's behaviour (positive or negative).

- *parameter*: the parameter associated to the factor;
- *getURL*: the URL where the value for the parameter can be retrieved.

No changes were made in this table's structure, only in the way the factors were used. In the previous version of the *Persuasion Module,* the factors were used to explain deviation to activity patterns and could have associated positive or negative effects. Since the rules were fewer and simpler, the factors could be more generic, but in this new version however, there are no negative effects, only positive and there are more rules created with higher complexity where one rule can have data from various sources as parameters.

One alternative would be to create one universal factor that could encompass all the parameters, but that option was discarded since it would turn the factors validation step in the rules process obsolete.

So, by already having in mind the rules that will be stored in the table *RuleTable,* the factor associated with a specific rule will encompass the parameters associated with that rule.

For example, the rule *ReachedGoalWeek* that checks if the user reached his exercise goal for the week, has the parameters: exercise goal, completed activities history and *Fitbit Daily Summary* for that week. Since all its parameters' values come from different sources, a factor was created that combined all the parameters (*comboFbCaG*).

The same idea was applied to other rules that required information from different sources. If a rule uses planned activities and *Fitbit* information, the factor would be *comboFbPa*.

**ValidFactors Table**

This table stores the factors that can explain the deviation, generated in the *COMBFinal* module;

- *userId:* the user's auth0;
- *date:* the date this information is stored in the database:
- *numberOfFactor:* the factor's number, automatically generated through an increasing variable;
- *factor:* is associated with which type of parameters are necessary for a specific rule;

- *numberOfParameters:* the number of parameters associated to the factor;
- *numberOfParametersTotal:* the total number of parameters.

**RuleTable Table**

This table, used in the module *BCTSelectionFinal*, contains the rules that will be triggered according to the values retrieved from the table *FactorsEffect* and has the following fields.

- *factor:* is associated with which type of parameters are necessary for a specific rule;
- *file:* the .class file containing the rule;
- *parameters:* all the parameters associated with the factor;
- *bct:* the message identifier for the specific rule;
- *triggerHour:* the hours at which the rule must be activated where each hour is associated with a number;
- *triggerDay:* the week days at which the rule must be activated;
- *application:* the application where the message will be shown.

No changes were applied to this table, and all the new rules were inserted. The messages, trigger hours and trigger days were decided in partnership with the psychologists.

**FactorAndBCTReturned Table**

This table stores the following values after executing the module *BCTSelectionFinal*.

- *userId:* the user's auth0;
- *date:* the date this information is stored in the database:
- *factor:* is associated with which type of parameters are necessary for a specific rule;
- *bct:* the message identifier for the specific rule;
- *application:* the application where the message will be shown.
- *totalBCTReturned:* the number of bct's returned.

**BCTMessages Table**

This table contains the persuasive messages associated with the different rules and is used in the module *BCTInstanceFinal*.

- *factor:* the factor associated with the rule;
- *bct:* the message identifier;
- *message:* the persuasive message;
- *priority:* the messages priority.

Given the fact that this new iteration of the Persuasion Module would consider the users' language when creating the persuasive messages, the following changes were made to the *BCTMessages* table:

- Two new columns were added, *messageDe* and *messageNo.* The first contained the German translation of the persuasive messages and the second contained the Norwegian translation.
- The column *message* was changed to *messageEn* containing the English translation of the messages.

**MessagesCreated Table**

After the last module is executed, this table stores the messages that are sent to the Adaptation Engine.

- *userId:* the user's auth0;
- *date:* the date this information is stored in the database:
- *message:* the final message;
- *key:* the application where the message will be shown.
- *totalMessages:* the number of messages generated.

### 6.1.4 Modules

The following modules were modified in order to apply the necessary changes to the *Persuasion Module* described in Chapter 5 (Design).

One change that was replicated in the three modules (*COMBFinal*, *BCTSelectionFinal* and *BCTInstanceFinal*) was deleting all the previous persuasive notifications in the *Adaptation Engine* and the start of the module's execution. Previously the persuasive notifications were deleted in case of error, but since the rules

that remain in the *Adaptation Engine* after being triggered turn obsolete, it was better to delete them every time the *Persuasion Module* is executed.

Another aspect that required attention was related to the special characters present in the user identification (*auth0|*). In an earlier version of PIQL, the character "|" (pipe) was replaced with its encoded version *%7C* in the table *userId* in the *personaal* database so that it could be used in URLs to get/send information from/to the *Context Manager* as well as the *Adaptation Engine*. However, using the encoded version of the *userId* prevented the *Notification Application* to receive the persuasive messages, so the original *userId* was replaced in the database and in the various modules and rules of the *Persuasion Module* any URL that used the auth0| was encoded instead.

**COMBFinal**

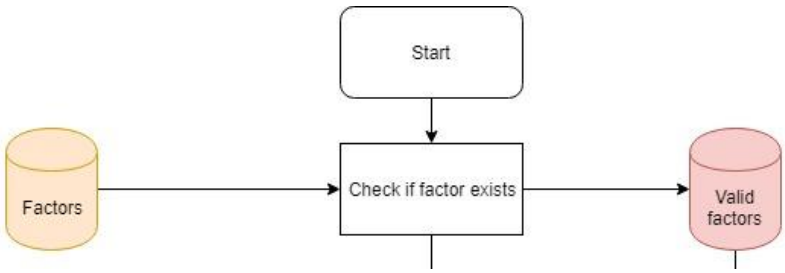


*Figure 12 – Part of the rule processing associated with the module COMBFinal*

Since activity patterns and the deviation to those patterns are no longer detected, this module is responsible for checking if the URLs stored in the *FactorsEffect* table are valid for each factor and if yes, the module fills the table *Valid Factors*, as shown in the Figure 12, with the valid factors and number of parameters associated.

The URLs stored in the *FactorsEffect* table are not associated with specific users, or specific dates (if the URL has a date field) so, in this module, when the URLs are retrieved to check if they are valid, they must be parsed first and be constructed again with the specific user and, if necessary, with the specific date.

The following example refers to the URL used to retrieve the exercise goal:

*https://giove.isti.cnr.it:8443/cm/rest/user/userId/environment/exerciseGoal/*

The field *userId* is replaced by the user's real identification (*auth0|*) retrieved from the table *UserId.* Ideally there would be no need for such a table in the database, as the *Authentication Server* could provide the user's identification, but since the partner

responsible for this component did not offer a service to access the users' *auth0*, they had to be stored in the database.

There are also the cases of URLs that return data associated with a specific date or with a specific period of time, i.e., have a history. For example, it is possible to retrieve the *Fitbit Daily Summary* for a specific day or for a period of time.

The REST services available in the *Context Manager* allow to retrieve information with history (*Fitbit Daily Summary* or *Completed Activities*) in various ways:

- The last n values added:

  *https://giove.isti.cnr.it:8443/cm/rest/user/userId/.../history/getNlastValues/{numValues}*

- For a specific date:

  *https://giove.isti.cnr.it:8443/cm/rest/user/userId/.../ history/getValuesOnDate/{YYYY-MM-DD}*

- Between two dates:

  *https://giove.isti.cnr.it:8443/cm/rest/user/userId/.../ history/getValuesBetweenDates/date1/{YYYY-MM-DD}/date2/{YYYY-MM-DD}*

- From a specific date until the current date:

  *https://giove.isti.cnr.it:8443/cm/rest/user/userId/.../ history/getValuesFromDateToNow/{YYYY-MM-DD}*

- Before a specific date:

  *https://giove.isti.cnr.it:8443/cm/rest/user/userId/.../ history getValuesBeforeDate/{YYYY-MM-DD}*

As will be further explained in the section 6.2.7 (REST service for planned activities), the REST service to retrieve the planned activities created in the *Remote Assistant* application offers the same methods using the same syntax.

Like the user, the dates are not specified in the URLs stored in the database, so a nomenclature had to be chosen to address the different dates and time periods depending on the rules' parameters allowing for more flexibly.

The simplest case is if a rule requires a specific date. For example, if a rule received as parameter all the completed activities the user had on the 12th of October 2018, here the URL can be stored directly in the database with the date already attached.

*https://giove.isti.cnr.it:8443/cm/rest/user/userId/activity/CompletedActivites/history/getValuesOnDate/2018-10-12*

However, at the present time, the rules created do not use a specific date. Some rules require the user's activity of the previous day or the user's activity of last week. In these cases, the dates are not fixed and as the Persuasion Module is executed every day, the dates will also change every day.

Based on the rules created with the psychology partners and the periods of time that could be used on those rules, the following syntax was chosen to express the date that needed to be stated in the URL:

- *T* means the today's date;
- *D-n* translates to today's date minus *n* days;
- *M-n* translates to today's date minus *n* months;
- *Monday* is the current week's Monday;
- *Sunday* is the current week's Sunday;

Then, it's the module's responsibility to, before checking if the URL is valid, replace the *userId* with the user's *auth0* and check if the URL has a history field and if it is required to replace it with the correct dates in the correct format (*yyyy-MM-dd*). In the following example, the module must check what is the current date and then convert the previous' day date to the format *yyyy-MM-dd*.

*https://personaal.cloud.reply.eu/rest/user/userId/PlannedActivity/history/getValuesOnDate/D-1*

Only then the URL is accessed and validated. In its previous version, the module would check if the JSON returned by the URL had a field *value* to confirm that it was valid. This was due to the fact that for the rules that were created at the time, the URLs in the database would always have the following format:

```
{"entityName":"meetGoal","environmentId":"auth0|5ab2b22ccf2dd9296d671dc9Env","msg":"Current value","status":"CURRENT_VALUE","value":"1"}
```

Now with more sources of data which can be returned in various formats with various syntaxes, it was necessary to accept any returned JSON regardless of its fields.

At the end of the module, the factors that are associated with valid URLs are stored in the *ValidFactors* table to be used in the next module.

**BCTSelectionFinal**

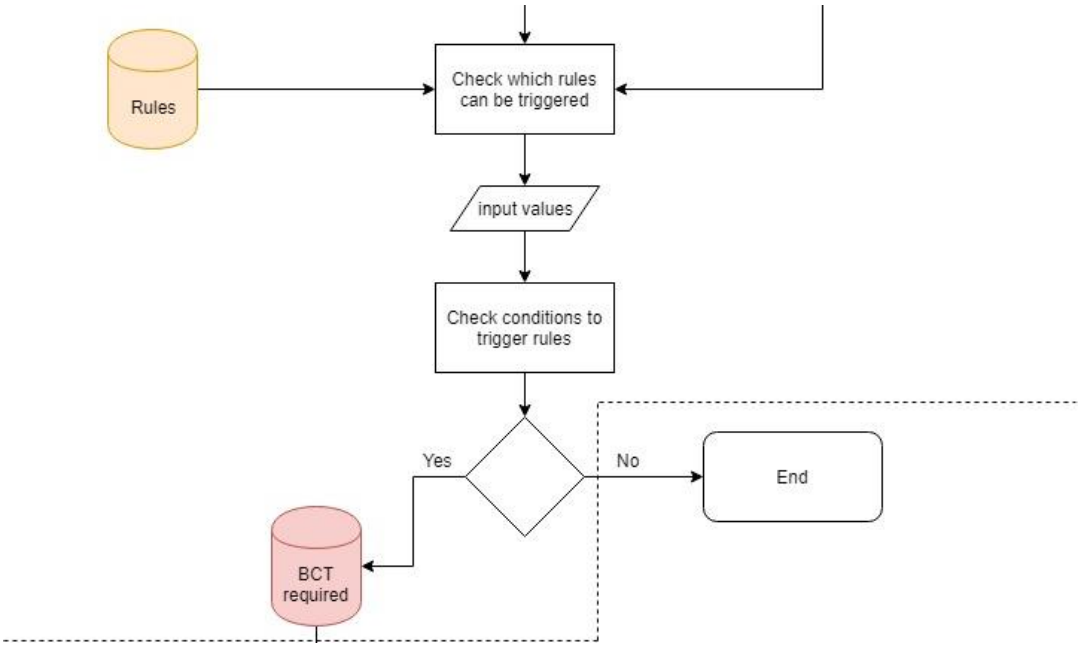


*Figure 13 – Part of the rule processing associated with the BCTSelectionFinal module*

This module is responsible for triggering the rules if certain conditions are met (Figure 13). First, the module must access the database's *RulesTable* table and check if the current time and date correspond with the ones associated when a specific rule is supposed to be triggered (i.e. if the fields *triggerHour* and *triggerDay* match the hour and day the *Persuasion Module* is being executed). Second, if the condition inside the .java file associated with each rule are met. This .java file is where the rules given by the psychologists in natural language, are translated to a programming language (in this case, Java) and return a Boolean representing if the conditions were met or not.

Retrieving the already validated factors, stored in the *ValidFactors* table by the previous module *COMBFinal*, this module goes through the same process of replacing the URLs of the valid factors with the correct *auth0*s and dates (if applicable). This time however, the values returned by the URLs are saved to be used as parameters for the rules.

Given the increased complexity of the rules imposed by the psychologists, where some require the average steps the user walked the previous week (ex: *more steps than typical day* and *less steps than typical day*), values like the average cannot be retrieved directly from the *Context Manager* but must be calculated using the information from the *Fitbit Daily Summary*.

This also increases the complexity of the values returned by some of the URLs (the *Fitbit Daily Summary* can return a relatively long string in JSON format) so, if the value returned is not an *Integer*, *Double* or *Boolean*, it is always treated as a *String* and it is inside the rule file that the string returned is converted to JSON format or other format that the rule may require. It is also inside the rule file that the parameters values are parsed and calculations made.

All the rules return a *Boolean* value and, for the rule to be triggered, that *Boolean* must be *True.* When a rule is triggered the associated factor, the application where the message will be shown and the BCT (the message's identifier) are stored in the *FactorAndBCTReturned* table.

As stated in previous sections, the messages generated by the *Persuasion Module* can be generic or personalised with the user's related information. That information will only be known during the process of triggering the rule (i.e. inside the rule file) and therefore must be stored so that the next module, *BCTInstanceFinal,* who only deals with building and assembling the final message and does not have access to the rule files and its parameters values, is able to access that value and use it to generate the message.

The *Context Manager* contains a field *environment* where the URL *https://giove.isti.cnr.it:8443/cm/rest/user/userid/environment/* allows to create a new entity and store any variables for a specific user. Now, to be able to add the *userId* to the URL inside the rule file so that the information can be sent to the correct user's environment, the user's *auth0* also has to be sent as a parameter to every rule file. If the rule is triggered the value to be shown in the message is sent to the *Context Manager* through a GET request and will be further explained in the next module.

**BCTInstanceFinal**

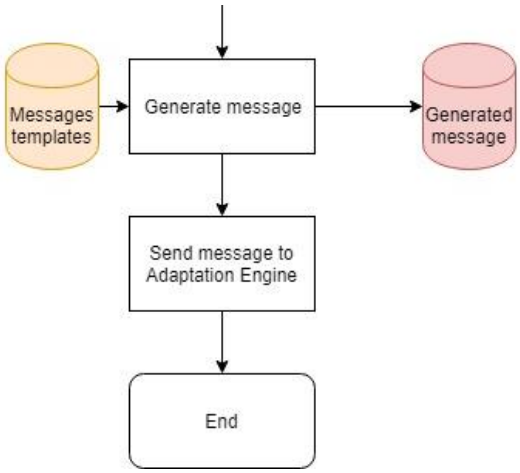


*Figure 14 - Part of the rule processing associated with the BCTInstanceFinal module*

This module is responsible for creating the final message that will be sent to the *Adaptation Engine* and ultimately be shown in the application specified in the table *RuleTable* (Figure 14).

The module knows which messages from the *BCTMessages* table will be used for creating the final message by checking which *factors* and *bct*s were stored in the table *FactorAndBCTReturned* by the previous module. Once the process is complete, it is necessary to find which language is associated with the user, so that the correct translation is chosen.

As stated in the design chapter, the rules' messages can be of three types (rational, motivational and social). While it is possible for a rule to have associated only one message, some rules can have three different messages associated, each one with the same BCT, where in the end, one of these messages is chosen randomly to be a part of the final message. For each message, the corresponding translations in English, German and Norwegian (the languages spoken by the test users) are also stored.

The language is chosen by the user when accessing the *Remote Assistant* application and is sent to the *Context Manager* as will be further explained in the section 6.2.3 (Communication with the *Context Manager).* In the case the user never used the *Remote Assistant*, by default, the language stored is English.

The value corresponding to the user's language is returned from the *Context Manager* using a GET method with the following URL: *https://giove.isti.cnr.it:8443/cm/rest/user/userId/language*

Once the language is known, then the correct field in the *BCTMessages* table is used to create the persuasive message. If the value returned is *de* (German) the message is chosen from the *messageDe* column, if it is *no* (Norwegian) the message is chosen from the *messageNo* column. In case the value returned is not one of the two above, the message is always chosen from the *messageEn* column, making English the default language.

As also mentioned before, the messages generated by the *Persuasion Module* can be standard or personalized with information regarding the user. For the rules that will generate personalized messages, the values that will appear in the message must be saved and made available when the current module builds the message to then send to the *Adaptation Engine*.

The following rules have personalized messages:

- More steps than typical day;
- Less steps than typical day;
- Exercise Reminder;
- 70 max pulse;
- Morning social reminder;
- Morning walk reminder;
- Morning exercise reminder.

As stated in the previous module, if a rule is triggered and the associated messages must contain specific values, those values are sent to the *Context Manager* using the *environment* field.

For example, the rule 70 max pulse, has associated the message: *Yesterday you spent <var>pm_veryActiveMin</var> minutes doing intense physical activity*, where the string associated with the value to be shown is delimited by the tag *<var>* and *</var>*.

Since that message requires information that can only be accessed inside the rule file, that information is associated with a variable that is sent to the environment field in the context manager through a GET method with the following url:

*globalPath* + *userEncoded* + "/environment/" + *entity* + "/" + *value*

Where:

- *globalPath*: *https://giove.isti.cnr.it:8443/cm/rest/user/;*
- *userEncoded*: the encoded userId;

- *entity*: the entity to where the value is sent, equals the string between the <var>…</var>;
- *value*: the information that is to be shown in the message, can be a number or a string.

As that information was sent in the previous module (*BCTSelectionFinal*) the current module is responsible for checking if the messages in the table *BCTMessages* contain strings surrounded by <var>…</var>.

If that is the case, the message is split, and the string located between <var> and </var> is used to build the URL to get the value from the *Context Manager*. To continue with the same example, the entity *pm_veryActiveMin* that was created (or updated if it already existed for that user), will now be accessed through the following call

*https://giove.isti.cnr.it:8443/cm/rest/user/auth0%7C5ab2b22ccf2dd9296d671dc9/environment/pm_veryActiveMin*

that will return:


```
{
  "entityName": "pm_veryActiveMin",
  "environmentId": "auth0|5ab2b22ccf2dd9296d671dc9Env",
  "msg": "Current value",
  "status": "CURRENT_VALUE",
  "value": "12"
}
```


The field *value* is saved, and the correct message is created by joining the first half of the original message + *value* + second half of the original message.

Each message also has a priority associated with a scale from one to three (from the highest priority to the lowest), that will be used to determine the order the messages will appear when assembling the final message. Once all the messages for the user are generated, the priority values are retrieved from the *RuleTable* table and used to create the final message with all the rules' messages ordered by priority. Only then the final message is sent to the *Adaptation Engine* which will send it to the user's application (Figure 15).

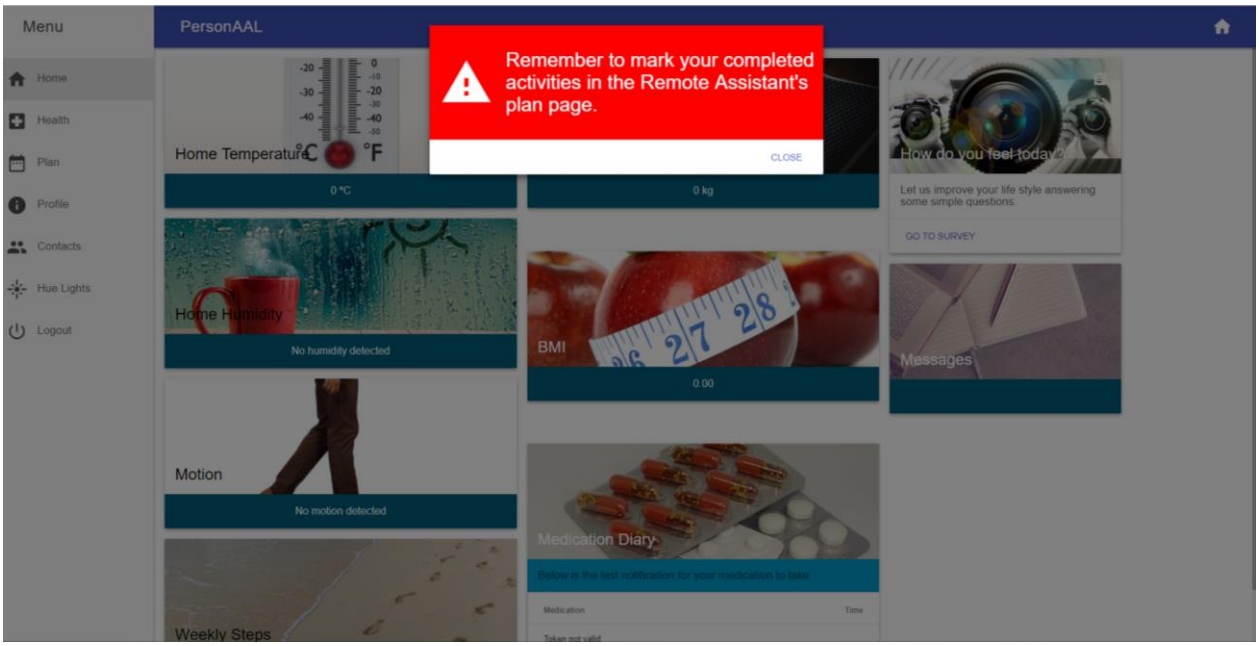


*Figure 15 – Generated message showing in the Remote Assistant application*

### 6.1.5 Execution

To run the *Persuasion Module*, it is necessary to create capsules trough *Gradle* in Eclipse. Since the modifications were focused only on the last three modules, the updated capsules were:

- *serverCapsule*: related to the servlets server;
- *behaviorCapsule:* related to the third module, the behaviour model;
- *bctCapsule:* related to the forth module, the persuasion techniques;
- *messageCapsule:* related to the fifth module, the persuasive messages;

The Persuasion Module is stored in the accessible-serv.lasige.di.fc.ul.pt server and is executed with the following options:

| Universal command | Capsule name | Option CommandLine | Execution type | User |
|---|---|---|---|---|
| java –jar | <capsule name> | <CommandLine> | <Module> or <Global> | <empty> or <All> |

*Table 2 – Arguments to run the CommandLine option*

Since we want to run from the third module forward for all the users in the table *UserId* in the *personaal* database, the command should be:

*Java -jar COMBFinal-1.0-SNAPSHOT-capsule.jar CommandLine Global All*

The *Persuasion Module* is programmed to automatically run every hour by using the *Crontab* tool. With this tool it is possible to execute commands at a specific hour defined by the user.

## 6.2 Remote Assistant

The *Remote Assistant* application code is available on GitHub[7] and is written using the PHP and JavaScript programming languages.

In its original state, the code was structured so that each page in the application had a corresponding PHP file (*contacts.php, plan.php, login.php, profile.php, index.php, health.php*), where the functions related to exchanging information with the *Context Manager* are in JavaScript files. As the application allows the user to select between three languages (*English*, *German* and *Norwegian*), there are three PHP files containing all the strings available in the application in those three languages (s*trings_en.php*, *strings_de.php* and *strings_no.php*).

### 6.2.1 Libraries used

The application was initially built using *Material Design Lite* (MDL)[8], a library of components for web development based on Google's *Material Design*.

When adding new functionalities to the application, all the components used were based on MDL to keep a coherent design and to avoid conflicts between the various components.

### 6.2.2 Structure

In the earlier version of the *Remote Assistant* application, the java functions responsible for the connection with the database, *Context Manager* and *Bitalino* were all located in the *DBinterface.js*, *context-data.js* and *health.js JavaScript* files respectively.

For a better code management, the following JavaScript files were created, where each file contains the functions to send the respective information to the *Context Manager* according to the page in the application where they are used.

- *contacts.js* was related to the *Contacts* page;
- *index.js* was related to the *Home* page;

[7] https://github.com/cchesta/PersonAAL_RemoteAssistant
[8] https://getmdl.io/index.html

- *plan.js* was related to the *Plan* page;
- *profile.js* was related to the *Profile page.*

### 6.2.3 Communication with the Context Manager

To send all the new information to the *Context Manager* it was necessary to request the partners responsible for the *Context Manager*, to create the endpoints that were missing as well as decide on a JSON format for the exchanged data.

Each of the following endpoints that were created can be used for the GET and POST methods.

- User language

  Endpoint: …*cm/rest/user/{userId}//language/{language}*

In the *Login* page, the user can select one of three languages (*English*, *German* or *Norwegian*). In choosing one, an URL is created that will be used to send the information to the *Context Manager* after the user confirms the login into the application.

The languages available were *English* as default, since it was the common language to all of those involved in the project, and *Norwegian* and *German* as the test participants available in the project spoke one of those languages.

- User profile

Endpoint: …*/cm/rest/user/{userId}/profile/*

Each of the fields in the JSON's body is associated with the corresponding field in the card *My Info* in the *Profile* page where the user can insert his personal information like *Name, Surname, Birth Date, Gender, State, City, Postal Code* and *Address.* This information is then sent to the *Context Manager* when the user saves his changes.

```
    Data: {
"name": "John",
"surname": "Personaal",
"birth_date": "1950-06-15",
"gender": "Male",
"state": "Belgium",
"city": "Brussels",
"postal_code": "1000",
"address": "3 Rue du Luxembourg"
}
```

- User interests

Endpoint: *.../cm/rest/user/{userId}/interest_list/*

Also in the *Profile* page, the user is able to select various interests, which are divided into categories. Every time the user selects or deselects an interest, a list of all the interests currently selected is sent to the *Context Manager*, where each entry has the interest's name and category.

```
Data: {
"interest_list": [{
"interest_name": "sport",
"interest_category": "Swim"
},
{
"interest_name": "television",
"interest_category": "Documentary"
}]}
```

- User contacts

Endpoint: *…/cm/rest/user/{userId}/contact_list/*

In the *Contact's* page every time the user adds a new contact, a list of all the contacts is sent to the *Context Manager* where each field of the JSON's body is associated to a field in the *Add Contact* card like the contact's *Name, Phone Number, Email* and *Relationship.*

```
    Data: {
"contacts_list": [
{
"name": "Mary",
"phone_number": "123456789",
"email": "mary@gmail.com",
"relationship_type": "friend"
},
{
"name": "Peter",
"phone_number": "987654321",
"email": "peter@outlook.com",
"relationship_type": "close family"}]}
```

### 6.2.4 Home Page

In the *Home* page, a new card was added (using MDL components to be consistent with the remaining cards) showing the user's steps for the current week.

Using the GET method with the following URL to retrieve the Fitbit Daily Summary, the data retrieved corresponded to the values from Monday of the current week to the current day. To do so, it was necessary to find the Monday's date in the format *yyyy-MM-dd* and use it at the end of the URL.

*URL: contextUrl + "cm/rest/user/"+ userId +*
*"/activity/FitbitDailySummary/history/getValuesFromDateToNow/" + yyyymmdd*

Since the JSON returned is an array with several days' worth of data, not the number of steps for the current week, it is necessary to parse the steps from all the days and add them. In the end that steps total is shown in the respective *Home* page card.

### 6.2.5 Plan Page

**Weekly goals card**

As mentioned in the design section, the first changes in the *Set Weekly Goals* menu were changing the titles, which were done by altering the respective strings in the three files containing all the strings found in the *Remote Assistant* application in the English, Norwegian and German languages.

To be able to give the user more options to choose from in the different types of activities, the radio buttons were replaced with sliders. The slider used was one of the *Material Design Lite* (MDL) components consisting of a horizontal line with a small movable disc and a text field communicating the set value or where the user can insert his chosen value which will move the disc to the correct position.

For the range of values the user can select from in the *exercise* and *walk* activity, 4 hours per day were considered the maximum hours of physical activity an elderly user could maintain. Multiplying by the 7 days of the week, the highest hours goals for a week would be 28 hours.

For the *social activity* field, 6 social activities per day were considered enough social activities for an elderly user, making the highest value for a week, 42 social activities.

In the *View Weekly Goals* card, the same changes in the titles were applied. In the previous version, when the user finished an activity, the value for the time the user had

spent exercising, the number of steps during a *walk* activity and the number of people the user had met during a *social* activity, would be updated in the respective field in the database and retrieved when initializing the card. Now, however, that information is sent to the *Context Manager* and can be accessed through a GET ajax request with the following URL:

*contextUrl + "cm/rest/user/"+ userId +*
*"/activity/CompletedActivity/history/getValuesFromDateToNow/" + yyyymmdd,*

Since cards must show the progress for the current week, similarly to what was done in the *Home* page to show the user's total steps for the current week, the date used in the URL must be the current week's Monday date.

Once the user's completed activities since Monday are retrieved, all the activities are parsed and if the fields *activity_type* equals *Exercise* then the value in the field *completed_duration* (the duration of the activity in the format *hh:mm*) is converted to hours and added to the progress.

Similarly, if the *activity_type* equals *Social,* the progress in the Social Activities field increases one value for each social activity completed in the calendar.

In the *Walk* progress however, the information analysed is not the completed activities, but the *Fitbit Daily Summary* also available from the *Context Manager.* The *Fitbit Daily Summary* is retrieved from the current week's Monday until the current day and the steps for each day added to a total as done in the *Home* page. Those steps are then used to calculate the number of hours the user walked using a rule of thumb that states the number of steps taken in half hour is 3000 steps, so the final result will be the number of steps divided by 6000.

**Calendar**

The first step was finding a calendar that met the requirements mentioned in the *Design* section.

Ultimately the chosen calendar was the *CalenStyle*[9], a responsive jQuery Drag and Drop Event Calendar for Web, Mobile Sites, Android, IOS and Windows Phone (figure 16). It was chosen because of its design that allowed to represent events in a colourful and informative manner and is designed to be shown in small screen like mobile devices, but still working well on desktop browser's larger screens.

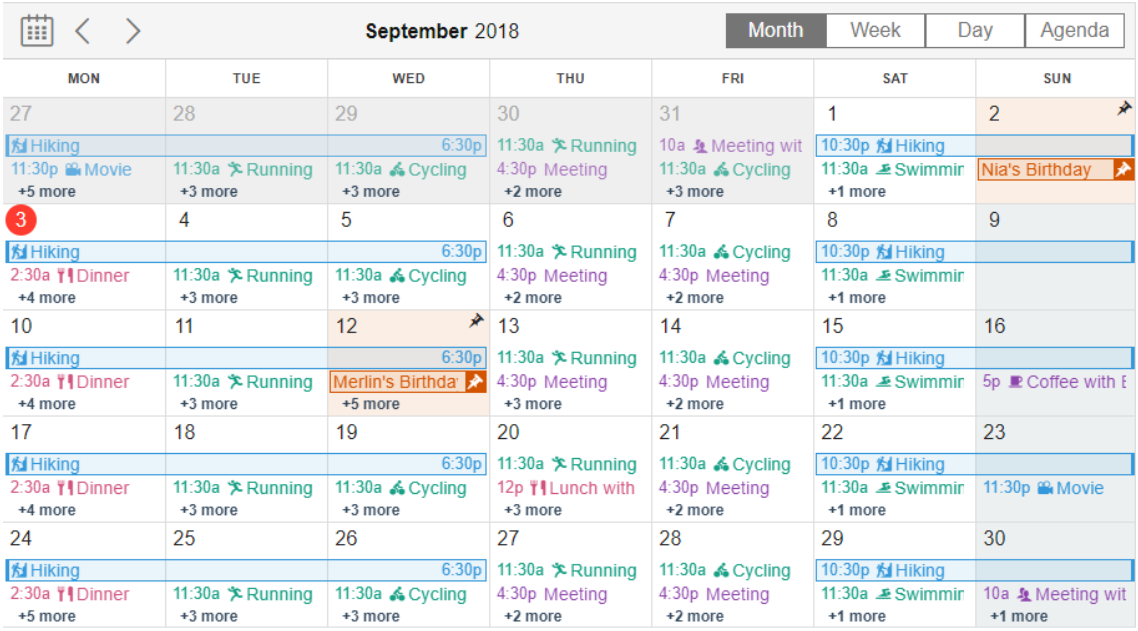


*Figure 16 –CalenStyle Month view example*

*CalenStyle* allows many different views but only three were used according to the requirements: *MonthView*, *WeekView* and *DayView*. They were considered the more important and practical and since they are the most common options in other similar event planner applications, the user would be more familiar with them.

Since one of the key elements of the *Plan* page lies on weekly goals, the default view of the calendar is the *WeekView*.

The hours displayed in the calendar are in the 24 hours format since the Remote Assistant's users were located in Europe and were confused by the format AM/PM.

Another aspect changed from the default calendar was the existence of the business hours that appeared in the calendar with a different colour. The users also felt that this aspect was unnecessary and confusing.

[9] https://github.com/nehakadam/CalenStyle

To meet these requirements, the calendar was initialized with the following parameter options as specified in the *CalenStyle* documentation:

```
      viewsToDisplay: [{
      "viewName": "DetailedMonthView",
      viewDisplayName: oViewDisplayNames["DetailedMonthView"]
      },{
      "viewName": "WeekView",
      viewDisplayName: oViewDisplayNames["WeekView"]},
      {
      "viewName": "DayView",
      viewDisplayName: oViewDisplayNames["DayView"]
      }],

      visibleView: "WeekView",

      is24Hour: true,

      businessHoursSource: [{
      day: 0,
      times: [{startTime: "00:00", endTime: "24:00"}]
      },{
      day: 1,
      times: [{startTime: "00:00", endTime: "24:00"}]
      },{
      day: 2,
      times: [{startTime: "00:00", endTime: "24:00"}]
      },{
      day: 3,
      times: [{startTime: "00:00", endTime: "24:00"}]
      },{
      day: 4,
      times: [{startTime: "00:00", endTime: "24:00"}]
      },{
      day: 5,
      times: [{startTime: "00:00", endTime: "24:00"}]
      },{
      day: 6,
      times: [{startTime: "00:00", endTime: "24:00"}]
}],
```

***Create an activity* menu**

Once again, having in mind the target audience, the steps to create an activity and add it to the calendar should be clear and straightforward, while giving the user the options to edit information already inserted and cancelling the operation altogether. Using a stepper seemed the best option, as it allows the user to know beforehand how many steps are left until the end of the task and at what stage of the process he's in.

The stepper implemented, the *MDL Stepper*, was based on *Material Design Lite* (MDL) library, once again to maintain a coherent design with the rest of the application. A vertical stepper was chosen, being more appropriate for mobile devices, with editable steps so that the user can return to previous steps and edit them.

The first step (*Confirm date and time*) consists of a check box named *All Day* where the user can check if the activity lasts the entire day, and two text fields, *Start time* and *End Time* (Figure 17). The date that appears in the *Start Time* is the date associated with the calendar cell the user clicked, and the one that appears in the *End Time* is by default the start date plus 30 minutes. If the user wishes to change these dates, by clicking in each of the text fields, a time picker will appear allowing the user to alter either the start date or end date.

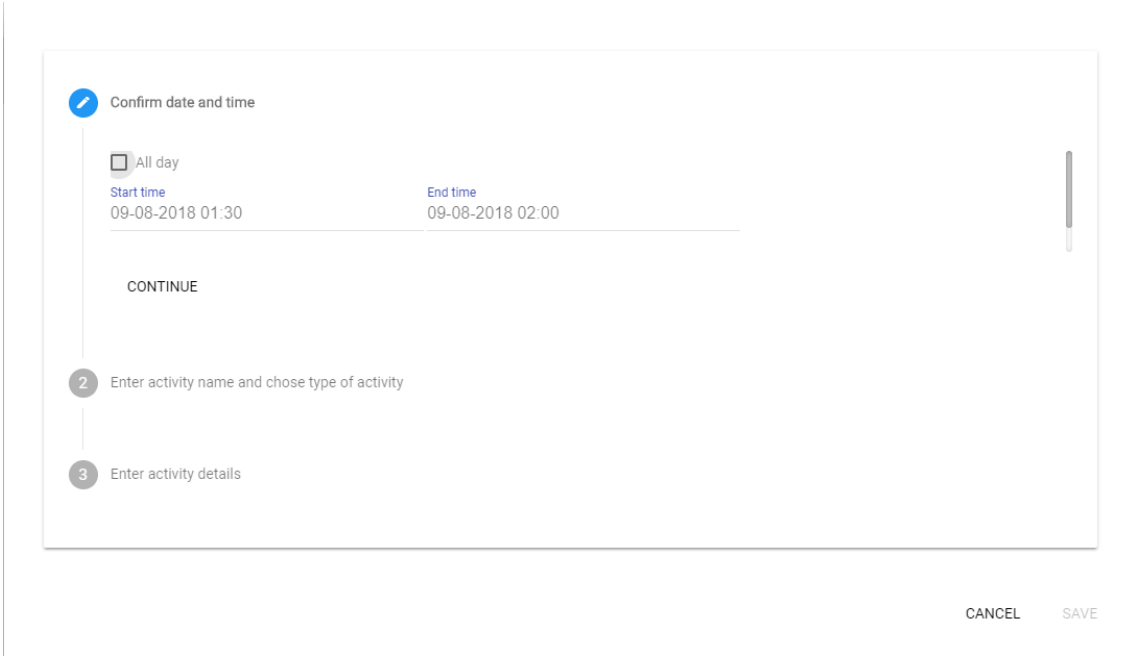


*Figure 17 – Stepper's first section (Confirm time and date)*

Given the requirements mentioned for the Time Picker, the one that was ultimately chosen was the *Material Datetime Picker*, a *Material Design* date/time picker modal built for the web (Figure 18). It was considered to be the most effective since it had a pleasant design in line with *Material Design Lite*, had a calendar view and a clock view providing an intuitive way of choosing the date and time.

If the *All day* box is not checked, the time picker opens in the clock view by default, showing the date and time that were in the start/end time text box.

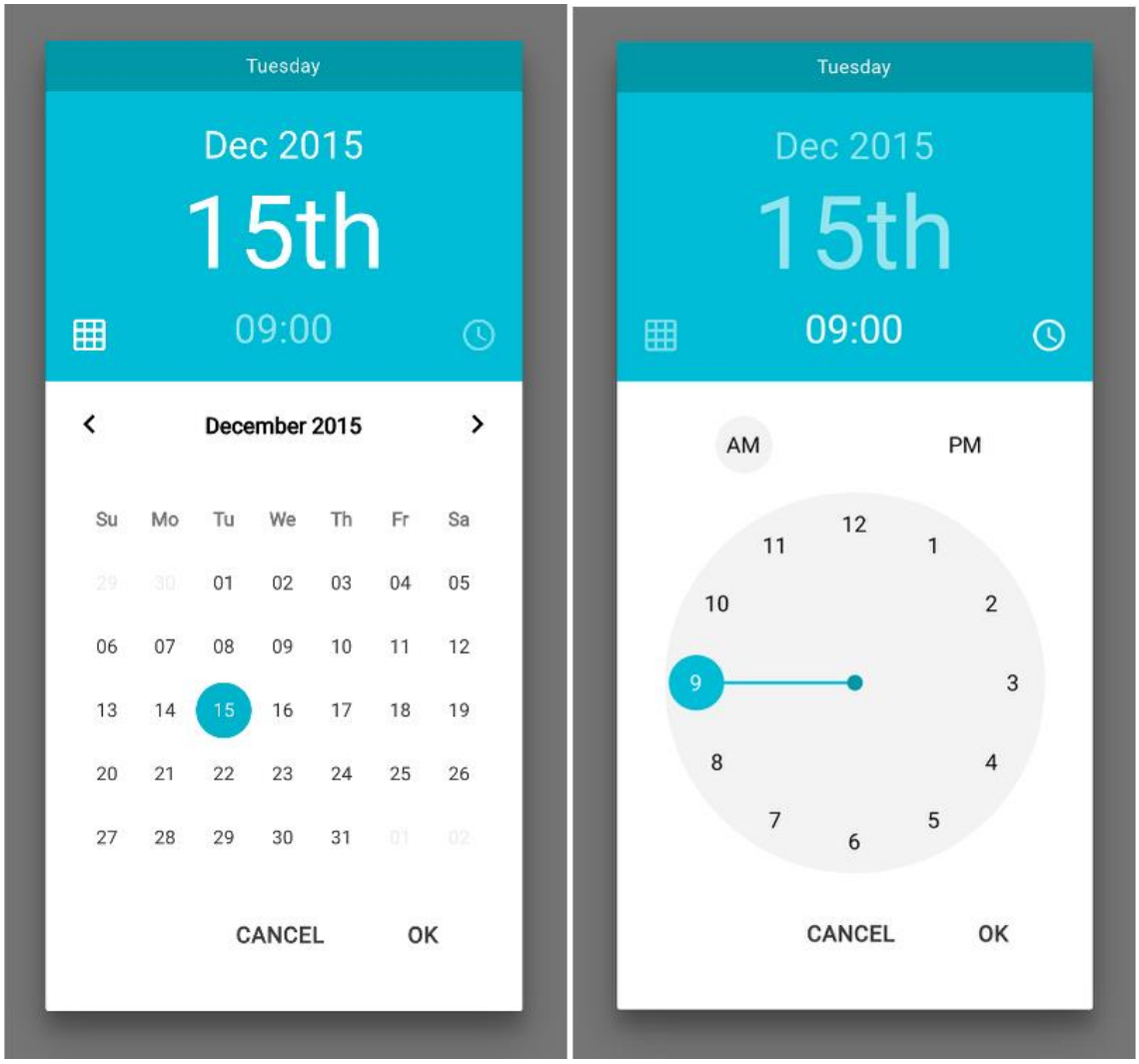


*Figure 18 - Material Datetime Picker*

Once the user confirms the date and time, the next step is *Enter activity name and choose type of activity.* In a text box the user can enter his name for the activity and has to choose between the three types of activities (*Walking, Exercise, Social Activity)* using radio buttons.

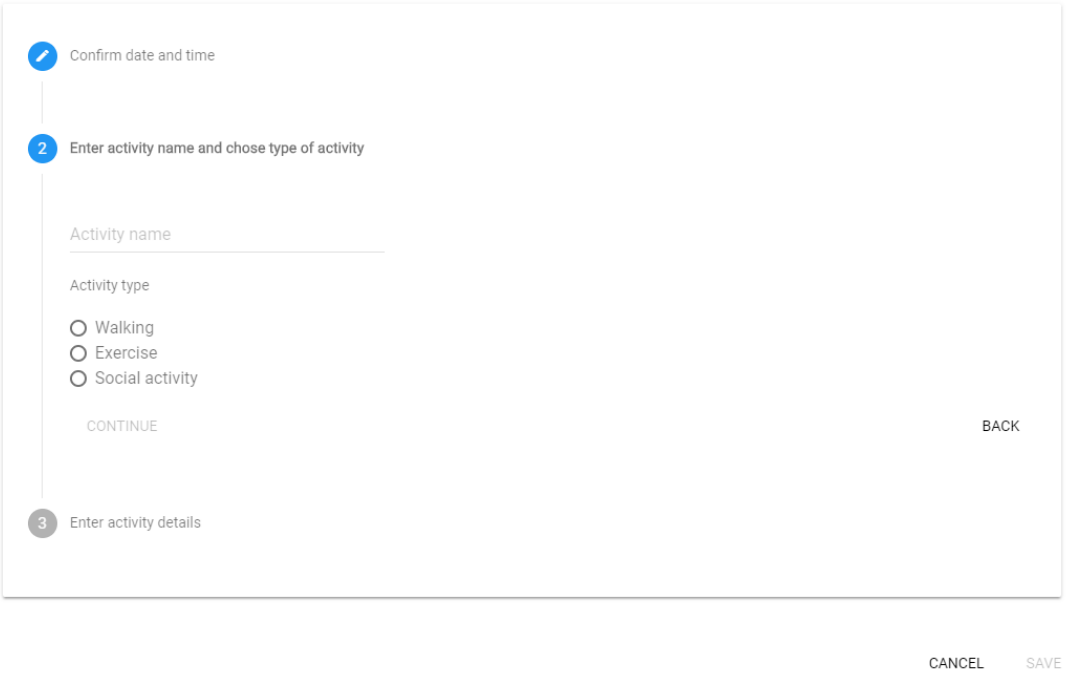


*Figure 19 – Stepper's second section (select activity's type)*

In the last step the user is required to *Enter Activity Details* (Figure 19). Depending on the type of activity, different options will be shown. In case the activity type is *Exercise*, the options for intensity are: *High* and *Moderate*. Initially there was also the option of a *Low* intensity, but the psychologists involved in the project felt that creating activities with low intensity should not be encouraged, so that option was removed.

If it is a social activity, the user can choose between the types of activities:

- *Receive guest;*
- *Call someone;*
- *Visit someone;*
- *Cinema;*
- *Theatre;*
- *Restaurant;*
- *Pub;*
- *Religious;*
- *Other.*

In case the activity is *Walk* no details are necessary, so the process ends in step 2. In the earlier versions of the stepper, the user could specify the number of steps they

would walk during the activity, but it was discarded since it would be very difficult for the users to know exactly or even have an idea of how many steps one can walk in a period of time.

Once the user has completed filling the information required to create an activity, the information is sent to the *remote_assistant* database and the activities must be shown in the calendar.

To add an entry to the CalenStyle, the calendar's function *addEventsForSource* is used whose parameters are a JSON object or string with the activities' information and the *sourceId* which is the variable associated with the calendar where those activities will be shown.

**Initializing the Calendar**

First a MySQL query is made to the database and an array is returned with all the activities' fields and respective values. Then that array is parsed and each activity in the array creates a new var *activityAdded* with the format specified in the *CalenStyle* documentation. Figure 20 has the calendar displaying four activities, two walk, one exercise and one social activities.

```
[{
"identifier": "1",
"isAllDay": false,
"start": "22-02-2014 09:00",
"end": "22-02-2014 10:00",
"calendar": "Meeting",
"tag": "Work",
"title": "Meeting with Ana",
"description": "",
"url": "",

"icon": "icon-Meeting",
"color": "20DAEC",
"borderColor": "000000",
"textColor": "000000",
"nonAllDayEventsTextColor": "000000",

"isDragNDropInMonthView": true,
"isDragNDropInDetailView": true,
"isResizeInDetailView": true
}]
```

Some of the fields were not included when creating the *activityAdded* variable since they were not considered necessary. The following fields were the ones used with the associated values:

- *id:* the activity's *activityId* field*;*
- *isAllDay:* the activity's *all_day* field
- *start:* the result of creating a new date using the activity's *start_date* field and a new Date() constructor;
- *end:* the result of creating a new date using the activity's *end_date* field and a new Date() constructor;
- *tag:* the activity's *type* field;
- *title:* the activity's *title* field;
- *description:* the activity's *intensity* field;
- *singleColour:* Blue if the activity's type is *Exercise*, green if it is *Walk* and brown if it is a *Social Activity.*
- *icon:* Similarly to the colour, the different types have different icons.

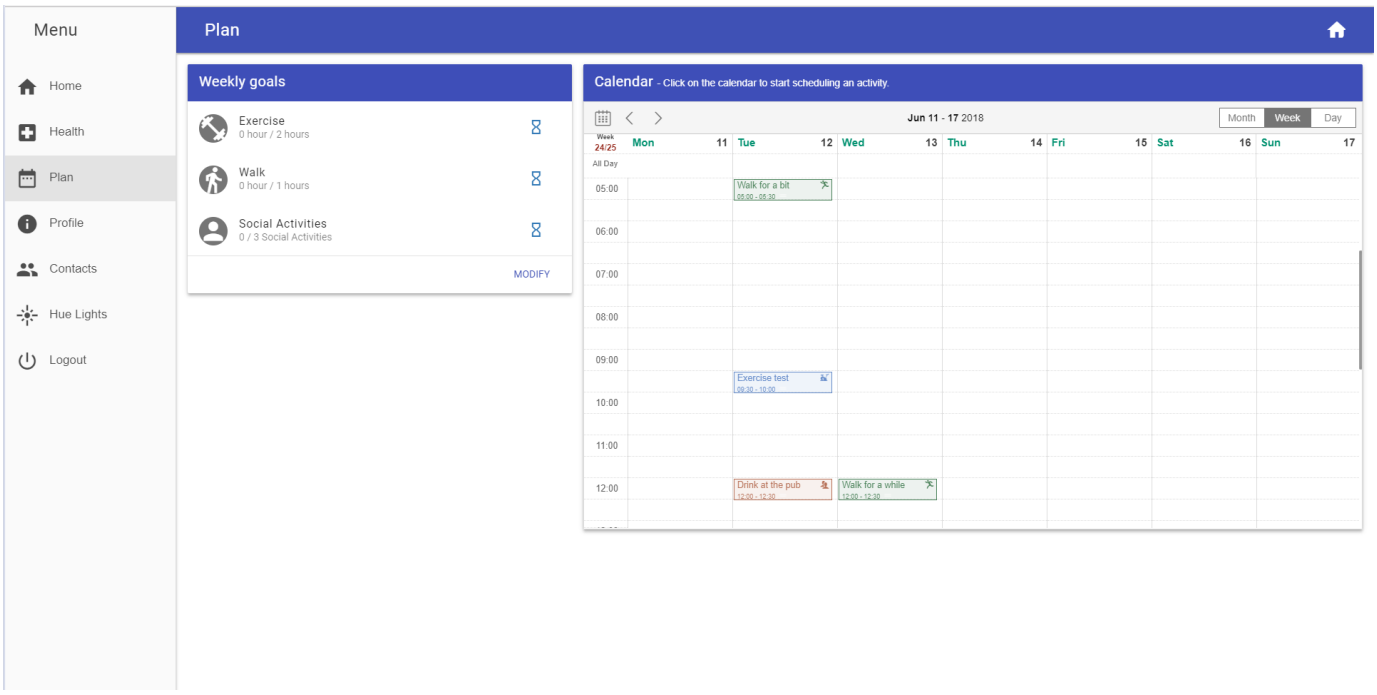


*Figure 20 – Plan page with the three types of activities added to the calendar*

**Mark activity as complete**

For the user to mark his activities as complete, in the *plan.php* file a new card was created using the *Material Design Lite* dialog component to maintain a cohesive design. To fill this card with the necessary information (name and type of the activity and its start time) the function *getActivitiesFromLastAccess* (located in the *DButils.php* file) is used returning all the user's planned activities whose start date is after the user's last access to the plan page.

The date when the user last accessed the application is stored in the *last_access_plan* column in the table user in the *remote_assistant* database. If between the date last_access_plan and the current date the user has planned activities with the field *done* equals 0, a card appears for each one of these activities.

Since the different types of activities are shown in the calendar with different colours, the cards will also have as background the colour associated with the activity that is being shown.

If the user marks the activity as complete, the activity is sent to the context manager as a completed activity, using the following endpoint:

*https://giove.isti.cnr.it:8443/cm/rest/user/{userId}/activity/CompletedActivity*,

with a payload with the following fields

- *activity_intensity:* The value inserted by the user in step 3. Since the *walk* activity does not have this step, the value sent is 0;
- *activity_name:* The title of the activity inserted in step 2;
- *activity_type:* The type of the activity chosen in step 2;
- *completed_duration:* The activity's duration;
- *completed_time:* The activity's start time;
- *completed_timestamp:* Filled automatically by the *Context Manager* when the information is sent.

The value *done* in the activity table changes to 1 and the *last_access_plan* field in the table *users* is updated with the current date and time.

**Show activities from the Activity Tracker application**

Since the user is able to plan activities in two distinct applications (*Remote Assistant* and *Activity Tracker*), it was important to offer the user the possibility of visualizing all the activities created to avoid the constant switching between the two applications.

But in order to show the activities created with the *Activity Tracker* application in the *Remote Assistant's Plan* page's calendar it is necessary to access the *Activity Tracker* to retrieve the activities. Given that the authentication sever uses *auth0* to protect its resources, the *Remote Assistant* application must first provide an *access token* to be allowed access to said resources. To do so, the following request is sent through a POST request to the URL:

*https://personaal.eu.auth0.com/oauth/token*

With the body:

```
{
"grant_type": "client_credentials",
"client_id": "client_id",
"client_secret": "client_secret",
"audience": "https://activity-backend-personaal.eu-de.mybluemix.net"
}
```

The *client_credentials* grant allows an application to request an access token using its *client_id* and *client_secret* where the *client_secret* protects the resources by only granting tokens to requestors if they are authorized. In this case the *client_id* and *client_secret* represent the *Remote Assistant* application (the one trying to access the information) and the audience represents the *Activity Tracker* (where is stored that information).

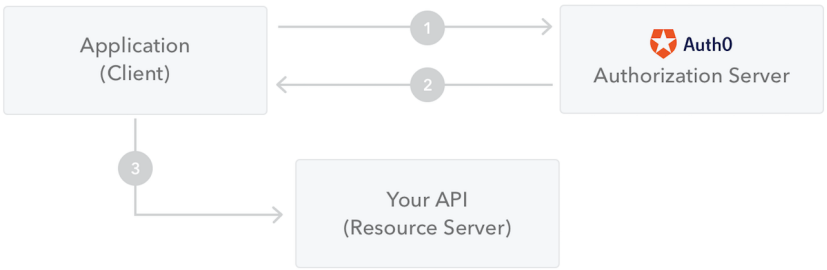


*Figure 21 – Client Credentials Grant Flow*[10]

[10] Client credentials grant flow image, accessed 10 October, 2018, https://auth0.com/docs/api-auth/grant/client-credentials#client-credentials-grant-flow

Once the token is retrieved a call is made to the *Activity Tracker* endpoint *https://activity-backend-personaal.eu-de.mybluemix.net/api/system/activities/userId* where the *userId* is replaced by the user's auth0.

The *Activity Tracker* returns a JSON with the following format


```
[
    {
        "username": "auth0|5afbf07f90ac0b1c29212280",
        "activity_name": "garden",
        "link_to_activity":"https://activity-personaal.eu-
de.mybluemix.net/assets/staticPages/household/household.html",
        "duration": "01:00",
        "activity_type": "1",
        "activity_intensity": "1",
        "activity_description": "",
        "start_date": "2018-08-06",
        "end_date": "2018-08-07",
        "notification_time": "16:08",
        "days_index": [
            "1"
        ],
        "days_name": [
            "Tuesday"
        ],
        "activity_intensity_name": "Moderate",
        "activity_type_name": "Household chores(gardening/home)"
    }
]
```


The same way that the data regarding the planned activities, was retrieved from the database and its values associated with the calendar's *eventSource* array, to add an activity from the *Activity Tracker* to the calendar the same must be done.

Here, there are two challenges regarding the JSON format that must be addressed so that the activities are displayed in their proper place in the calendar. First, regarding the activity's start and end times, the fields *start_date* and *end_date* only return the date of the activity with the format yyyy-MM-dd. Also, the activity's start time is given by the field *notification_time* with the format hh:mm, so it is not explicitly stated the activity's end time. Second, the *Activity Tacker* allows the user to, after selecting the activity's time frame, also select which days of the week the activity will take place. As so, it's the field *days_name* which will determine the activity's place in the calendar between the *start_date* and *end_date*.

Now, to know the activity's exact days, the field *days_name* which returns an array with the days of the week (*Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday)* when the activity will take place and the fields *start_date* and *end_date* which serve as dates limits are used. Using *moment.js*[11] and its functions *isSameOrBefore* and *isBetween*, for each day of the week given by *days_name*, the respective date in the format yyyy-MM-dd between the *start_date* and *end_date* is found.

To be able to associate the correct values in the proper format to the activity to be added to the calendar, first is necessary to concatenate the values from the fields *start_date* and *notification_time* to get the *start* field in the new *ActivityAdded.* To get the new *end* field, the value from the *duration* (*hh:mm*) field is added to the *start_date* + *notification_time.*

Finally, the new var *activityAdded* is created as described above when adding a new activity to the calendar with the following fields and its values taken from *Activity Tracker* JSON:

- *start:* the result of creating a new date using the activity's *start_date* field and a new Date() constructor;
- *end:* the result of creating a new date using the activity's *end_date* field and a new Date() constructor;
- *title:* the activity's *activity_name* field;
- *description:* the activity's *activity_description* field;
- *singleColour:* Lilac so it could be distinguishable from the activities created with the *Remote Assistant* application.

Once the activity is added to the calendar, by clicking on it a card will appear with the activity's name, description, start and end time and a link to the *Activity Tracker* application.

### 6.2.6 Remote Assistant Database

One of the changes made in the *Remote Assistant* database was to add a new table *activity* to the already existing *remote_assistant* database built in MySQL format aided by the tool *Adminer*.

[11] https://momentjs.com/

This database contained seven tables named *diet, find, fitness, plan, usercontacts, users, weight* and a new table *activity* was created to store information regarding the users' planned activities to be added to the calendar in the *Plan* page (Figure 22).

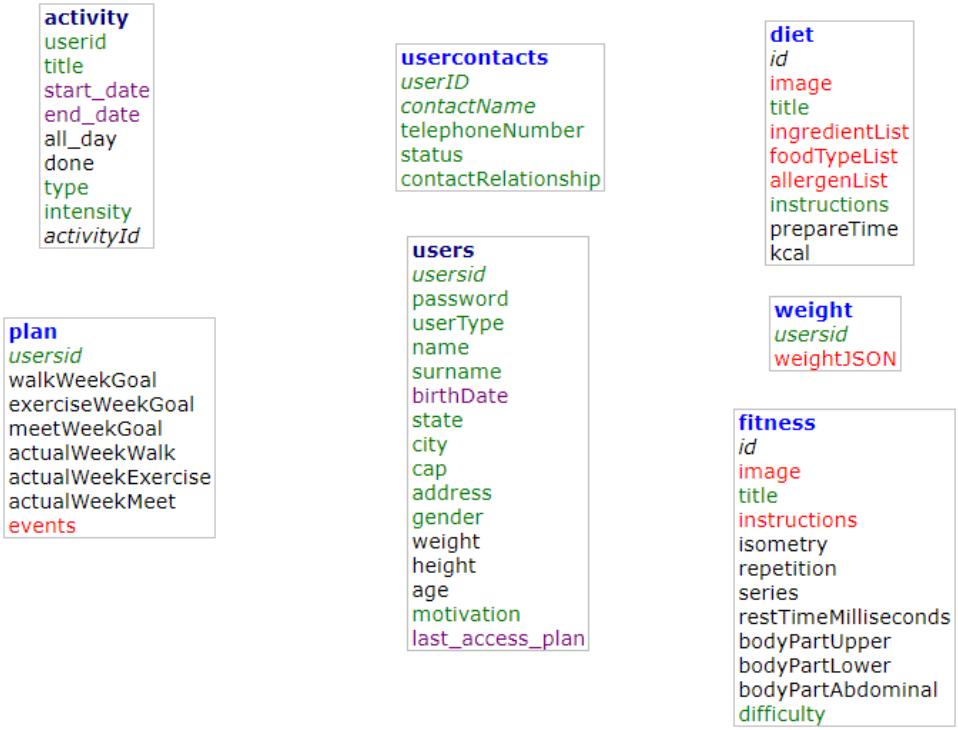


*Figure 22 - remote_assistan database schema*

The new table *activity* contains the following fields:

- *activityId:* an auto-increment *int*;
- *userid:* a *varchar* with the user's auth0 identifiers given by the *Authentication Server;*
- *title:* a *varchar* with the name of the activity given by the user on its creation.
- *start_date* and *end_date:* two *datetime* fields for the activity's start and end time respectively;
- *done:* an *int* that can have the value 0 if the activity has not been marked as complete by the user or 1 if so;
- *all_day:* an *int* that can the value 1 if the activity lasts a whole day or 0 if it does not;
- *type*: a *varchar* that can be *Walk, Exercise* or *Social;*
- *intensity:* a *varchar* that refers to different values depending on the activity's type.

In the table *users* was also added a field *last_access_plan* with the type *datetime* that is updated to the current time when the user finishes marking his activities as complete.

### 6.2.7 REST service for planned activities

As described in the Design chapter, the rules used in the *Persuasion Module* use information from various sources that are stored in the *Context Manager*. However, for a particular set of data, that was not the case. To be able to access information regarding the user's planned activities created in the *Remote Assistant* application, a REST service was created.

To keep the consistency with the other REST services used in this project, particularly the ones which deal with history like the completed activities or the *Fitbit Daily Summary*, the same GET methods were provided:

1. Returns all the planned activities for that user. *https://personaal.cloud.reply.eu/rest/user/{userId}/PlannedActivity*
2. Returns the last N activities for that user from the current date. *https://personaal.cloud.reply.eu/rest/user/{userId}/PlannedActivity/history/getNlastValues/{numValues}*
3. Returns the next N activities for that user from the current date. *https://personaal.cloud.reply.eu/rest/user/{userId}/PlannedActivity/history/getNNextValues/{numValues}*
4. Return all the activities that take place in the specified date for that user. *https://personaal.cloud.reply.eu/rest/user/{userId}/PlannedActivity/history/getValuesOnDate/{YYYY-MM-DD}*
5. Returns all the activities that occur between the two dates for that user. *https://personaal.cloud.reply.eu/rest/user/{userId}/PlannedActivity/history/getValuesBetweenDates/date1/{YYYY-MM-DD}/date2/{YYYY-MM-DD}*
6. Returns all the activities that occur from the specified date until the current date for that user (the specified date can be before or after the current date). *https://personaal.cloud.reply.eu/rest/user/{userId}/PlannedActivity/history/getValuesFromDateToNow/{YYYY-MM-DD}*

This service will return the information regarding the activities in JSON format with the following structure:

```
{"listPlannedActivity":[{"userID":"auth0|5ab2b61acf2dd9296d671dff","title"
:"fixe printer","type":"Social","intensity":"Other","start_date":"2018-04-
20 12:30:00","end_date":"2018-04-20
13:00:00","all_day":"0","done":"1","activityId":"5"},"msg":"History
retrieved","status":"OK"}
```


In case the user did not plan any activities in the *Remote Assistant* application or does not have activities planned for the specified time period, and consequently there is no entries in the database, the following JSON is returned:


```
{"msg":"No planned activities for the specified date or
user","status":"OK"}
```


Since the field *last_access_plan* was added to the *User* table in the *remote_assistant* database and would be necessary to use that value in the rules for the persuasion module, another GET method was added.

*https://personaal.cloud.reply.eu/rest/user/{userId}/getLastAccessToPlan*

And the following JSON is returned


```
{"msg":"","status":"OK","value":"2018-08-16 17:24:02"}
```


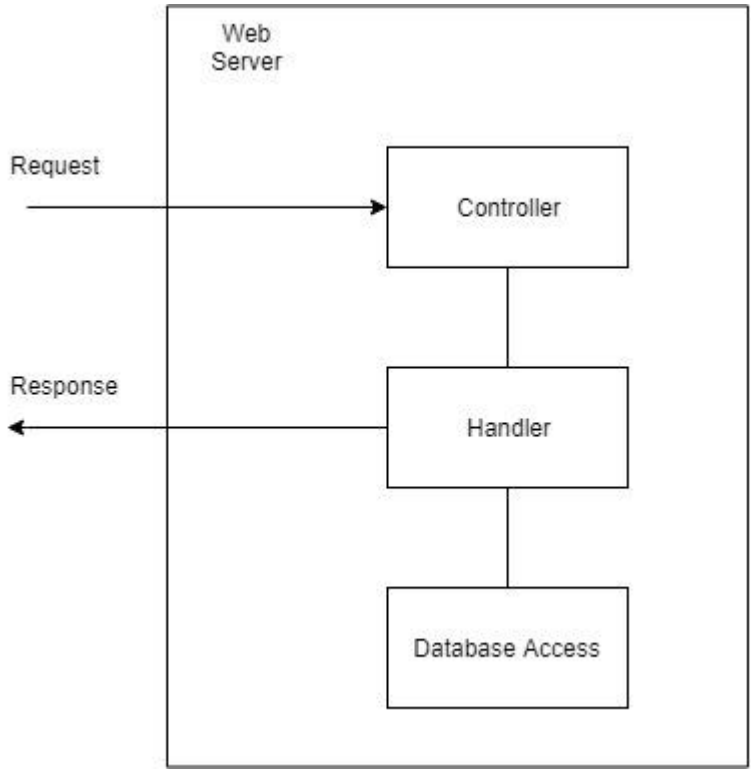


*Figure 23 – Planned activities REST service components*

The REST service was built using PHP and is composed by four components and is illustrated by the diagram in figure 23:

- *.htaccess:* First it is necessary to map the URL request and forward that request to the *Controller*. Each request is associated with a key *view* that can be *all* (all the activities for a specific user), *nNextValues* (the n next activities for a specific user), *nLastValues* (the n last activities for a specific user), v*aluesOnDate* (the activities planned for a specific day and user), *valuesFromDateToNow* (the activities from a specific date to the current date), *valuesBetweenDates* (the activities between two specific dates and user) and *lastAccessToPlan* (the date of the user's last access to the *Remote Assistant* application.
- *Controller:* By identifying the URL request with a key named *view*, the request is then dispatched to the respective methods in the *Handler*. In case the URL does not have the correct format, the *Controller* sets the response to 400 (*Bad Request*) and sends it to the *Handler* to be encoded.
- *Handler:* Where the REST request is handled, and queries are made to the database to build the response. It specifies the format JSON as the response format for the both the planned activities functions and the last access function. It also specifies the message in case the user does not have planned activities and in the case the user has and sets both responses with the status code 200 since both responses are considered valid when used in the *Persuasion Module* context (the fact the user does not have planned activities can be used to trigger rules). For the last access function, in case of success the status code is set to 200 and if the data returned is empty the status code is set to 404.
- *Database Access*: Depending on the request method, different queries are made to the *Remote Assistant* database so the correct planned activates can be retrieved.

# Chapter 7

# Evaluation

This chapter focuses on how the changes made to the *Remote Assistant* application and *Persuasion Module* were tested to ensure the correct running of the system. The trials with test users will also be discussed as well as its results and the questionaries' submitted, followed by a discussion of the problems found during this period.

Throughout the implementation stage, tests were made to guarantee the changes were integrated correctly into the system. In the *Remote Assistant* application, goals were set, activities were added to the calendar and validated that the information was stored correctly into the database. When testing the task of completing an activity, the information was being sent correctly to the *Context Manager* and the user's progress updated in the *View Goals* card. For the *Persuasion Module*, the messages were being created, stored in the database and correctly sent to the *Adaptation Engine* allowing to view the message in the *Remote Assistant.*

However, for the trials, the partners had their own development ambient and some changes had to be made on their end to run the system.

## 7.1 Field trials

The participants in the field trials, each associated with their own *auth0,* consisted of two users in Norway thereby identified by N1 and N2 and a couple in Switzerland thereby identified by S1. For the trials, each participant was given a tablet with all the PersonAAL applications installed, a chest band for measuring bio signals, and had hue lights installed in their home. Previously to the trial, Norwegian and Swiss researchers explained the operation of the PersonAAL system and applications to the participants.

Before the field trials' official start, one of the users in Norway had already tested for some time the *Remote Assistant* application, allowing to make improvements as mentioned in chapter 6 (Implementation) like changing the hour format in the Plan's page calendar.

The trials began at the end of July 2018 where all the participants were testing various PersonAAL applications like the *Remote Assistant, Persuasion Module* as well as the *Rule Editor, Activity Tracker, Medication Monitor* etc. and were concluded on 24th September 2018.

### 7.1.1 Problems found and improvements made

One obstacle found was that the data retuned for the *Fitbit* did not have a timestamp associated, making it impossible to use this information in rules that relied on specific dates since the only URL that showed the data was the ones containing *NLastValues.* So, the responsible partners had to be warned so that corrective measures could be taken.

Another problem regarded how the user's *Fitbit* data was collected and stored in the *Context Manager* where multiple entries were created for each day. This influenced the rules that would need to calculate an average (of steps or minutes) like the rule *More Steps Than Typical Day* or *Harder Than Usual.* The *Fitbit Daily Summary* used in these rules' java file as parameter had to be properly parsed before any calculations occurred since it returned many values for the same day. On the one hand, for the data retrieved with URLs using *getValuesOnDate*, the last known value for the day in question is the last element of the array *historyFitbitSummary.*

On the other hand, with other methods of retrieving dates like *getValuesFromDateToNow* or *getValuesBetweenDates*, it's necessary to select only one value per day and then calculate the average.

One aspect that only became apparent when the trial period began and the user's real data was analysed, related to some of the rules that dealt with the user's completed activities and rules that dealt with the time the user spent exercising. Rules like *More Exercise Last Week* or *Exercise Reminder* use the *Completed Activities* data to calculate the minutes the user spent doing physical exercise.

Originally, when parsing the completed activities json in the rule file (during the *BCTSelectionFinal* module's execution), the rule would only check if the *activity_type*

equals *Exercise*, meaning only the activities created in the *Remote Assistant* application were considered. During the first phase of tests, when examining the user's completed activities, many activities were also coming from the *Activity Tracker* application and not being taken in consideration. To also use the information from the *Activity Tracker*, it was necessary to decide which *activity_type* would be associated with exercise time. As described in chapter 3 (PersonAAL), there are 8 types of activities and the ones chosen to be equivalent to the *activity_type* exercises were: 3 (*cycling*), 4 (*swimming*), 6 (*running*) and 7 (*strength training*).

But there is also the case that, if the user does not have completed activities on a specific day, it does not mean that he did not spend time exercising. So, in this case, the rule would have to check the *Fitbit Daily Summary* for the same day. This presents another problem, where it has to be decided which fields to consider in the retrieved JSON. *The Fitbit Daily Summary* retrieved from the *Context Manager* has the following format:


```
{
  "lightlyActiveMinutes": 333,
  "veryActiveMinutes": 16,
  "fairlyActiveMinutes": 22,
  "restingHeartRate": 54,
  "heartRateZones": [
    {
      "max": 144,
      "min": 103,
      "minutes": 50,
      "name": "Fat Burn"
    },
    {
      "max": 175,
      "min": 144,
      "minutes": 0,
      "name": "Cardio"
    },
    {
      "max": 220,
      "min": 175,
      "minutes": 0,
      "name": "Peak"
    }
  ],
  "sedentaryMinutes": 1059,
  "steps": 8979,
  "floors": 28,
  "distance": 6.16,
  "elevation": 85.34
}
```

In various discussions with the phycologists in Norway, it was decided that the exercise minutes would be associated with the values *Cardio* and *Peak* from the field *heartRateZones.* The *Peak* zone means the user's heart rate is greater than 85% of the user's estimated maximum heart rate symbolizing high-intensity exercise, where the *Cardio* zone means the heart rate is 70 to 84% of the maximum heart rate symbolizing medium-to-high intensity exercise.

### 7.1.2 Remote Assistant

Besides other *Remote Assistant* functionalities, the test users were asked to use the *Remote Assistant'*s calendar in the *Plan* page to set their *exercise*, *walk* and *social* goals for the week and to schedule activities and report if they completed them.

In total, 52 activities were created with 34 activities reported as complete by the users (Table 3).

| User | Activities Planned | Activities Completed |
|---|---|---|
| **N1** | 43 | 27 |
| **N2** | 8 | 6 |
| **S1** | 1 | 1 |
| **Total** | 52 | 34 |

*Table 3 – Number of planned and completed activities by user*

In Figure 24 can be seen the activities created throughout the trials period (from the July 2018) as well as the first phase of preliminary tests.

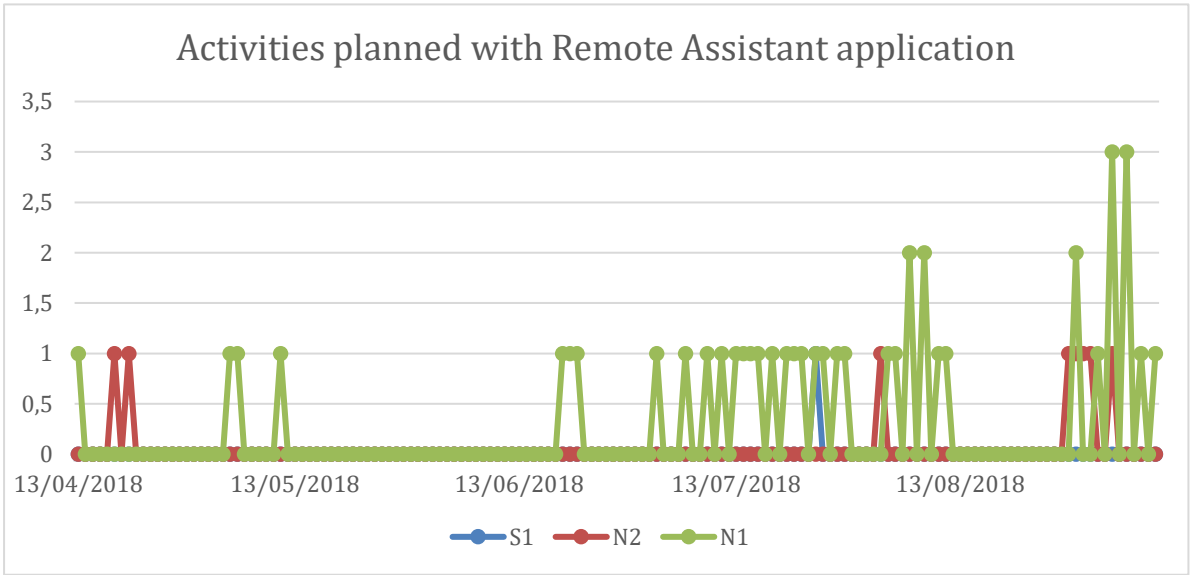


*Figure 24 – Activities planned with the Remote Assistant application by the users*

In terms of the types of activities, twenty-seven *exercise* activities were created, twenty-one *social* activities and four *walk* activities (Table 4). Except for the user *S1* who only created one activity in total, the *walk* option was the least used. With the other two users it is possible to see that where the user *N2* used the *Remote Assistant* application to schedule mainly *social* activities, the user *N1,* although with a significant number of *social* activities scheduled, focused more on creating *exercise* activities.

| User | Exercise | Walk | Social |
|---|---|---|---|
| **N1** | 26 | 3 | 14 |
| **N2** | 1 | 0 | 7 |
| **S1** | 0 | 1 | 0 |
| **Total** | 27 | 4 | 21 |

*Table 4 – Number of activities planned by type of activity*

Excluding again the user *S1* who only created 1 thirty minutes' *walk* activity, the *social* activities had a higher average duration than the exercise activities as can be seen in Table 5. The exercise activities scheduled did not vary much in their duration, showing that the users had a somewhat established work out plan.

| User | avg duration total (min) | avg duration exercise (min) | avg duration walk (min) | avg duration social (min) |
|---|---|---|---|---|
| **N1** | 113 | 63 | 95 | 210 |
| **N2** | 397 | 120 | 0 | 437 |
| **S1** | 30 | 0 | 30 | 0 |

*Table 5 – Average duration of the planned activities by type*

### 7.1.3 Persuasion Module

In the scope of the thesis *PIQL – Interfaces Persuasivas para uma Vida Saudável* (Silva, 2017), a series of question were made to 27 participants (14 females and 13 males) with ages between 55 and 95, with biggest representation being the ages between 76 and 85. These questions were regarding examples of persuasive messages like "Last week you reached your step goal. Don't you want to walk 10 minutes in order to reach your goal for this week?" or "The weather is nice today, don't you want to invite a friend to take a walk?".

When asked if these messages could motivate the user to be more physically active, 70% answered *yes* and 30% answered *no.* The same results were given when asked if the messages could motivate the user to be more socially active. When asked if

the user would like to receive this type of messages 58% answered *yes* and 42% answered *no.*

During the trial period, not counting messages generated for testing purposes, 326 messages in total were created (Table 6) and sent as notifications to the *Remote Assistant* and the *Notification Application*.

The most generated messages were the ones reminding the user to mark his activities as complete in the *Remote Assistant* application, as well as the ones reminding to schedule more physical and social activities so that the user could meet his weekly goals. Excluding these messages, 99 messages were generated for user N1, 44 for user N2 and 8 for user S1.

Besides the messages mentioned above, the most generated ones (24) for user N1 were related to the rule *Report Exercise* which suggested to the user to call someone and talk about the exercise accomplished in the previous day, followed by the messages stating the number of minutes the user spent exercising the previous day (21). This user also had 1 motivational message for reaching his exercise goal for the week, 2 for almost reaching his goal and 1 for reaching half of his goal. In terms of exercise intensity, 9 messages were generated for working out harder than usual, 11 for working out more than usual and 14 for doing intense physical activity. In terms of steps 8 messages stated the user had walked more steps than a typical day and 5 messages for walking less steps than a typical day. The user also had 2 messages as reminders of a social event not reported as complete and suggest the user's attendance.

Besides the messages stating the exercise done the previous day (13), the user N2's most generated messages were related to walking less steps than a typical day (7) and 5 messages associated with walking more steps than a typical day. The user also had messages related to working out more (6) and harder (6) than a typical day, as well as 2 messages congratulating for doing intense physical activity. The user also had 4 messages reminding him of social activities not reported as complete suggesting the user to participate in them.

Since user S1 seemed to be the least active, 4 messages were generated related to the rule *Less steps than previous day,* but also had 1 message congratulating him for working harder than usual and 1 for working more than usual, besides the 2 stating the number of exercise minutes the previous day.

| User | Persuasive Messages Created |
|---|---|
| **N1** | 153 |
| **N2** | 101 |
| **S1** | 72 |
| **Total** | 326 |

*Table 6 – Number of persuasive messages created by the Persuasion Module*

## 7.2 Questionnaires

At the end of the trials, the users were asked to fill a questionnaire, created and submitted by the psychology partners in Norway, regarding their experience with some PersonAAL components and applications. The questionnaires, which can be found in the appendix C, encompassed the user's experience with the *Remote Assistant*'s application, the *Persuasive Module* (focus on the persuasive notifications), the *Chestband*, the *Authoring Tool*, the *Notification Application*, the *Medication Monitor* and the *Activity Tracker* applications.

Regarding the *Plan* page in the *Remote Assistant*, the users were asked to rate how easy did they find performing the following operations in a scale from 1 to 5, where 1 was associated to *very easy* and 5 to *very difficult:*

- Set and modify the weekly goals;
- Insert a new activity in the *Plan;*
- Delete or edit an activity;
- Mark an activity as done.

The users were then asked if they had any comments and if they had any suggestions for improving the *Plan* page.

Regarding the *Persuasive Module*, the following questions were asked:

- Did the user find useful to receive persuasive notifications on their tablet? Could he describe some reasons why?
- Did the user think receiving these notifications could increase his physical activity levels? Could he describe some reasons why?

- Did the user think receiving these notifications could increase his social activity levels? Could he describe some reasons why?
- Was the frequency of the notifications appropriate? If not, would the user like to receive more, or it was annoying?
- Was the content of the notifications appropriate? If not, why?

The user *S1* reported in the questionnaires submitted that they did not receive any notifications in their tablet but felt that the messages could increase their physical and social activity levels, where the other two users who received them reported that they did not work out harder due to laziness and their social activity levels remained the same.

The users in Norway also commented on the frequency of the notifications, where one user wanted less messages and the other replied that the messages were amusing but would not want more. At last, one of the users stated that the message's content was not appropriate as sometimes he would receive praise for doing hard physical work when he had not, while the other said the content was appropriate.

When filling the questionnaire regarding the calendar in the *Plan* page, the tasks seem to have been performed relatively easy by the users (Figure 25). The task to set and modify the weekly goals was deemed very easy by all the users. To insert an activity in the calendar, for one user the task was very easy, for another was easy but one user found it difficult because it required a lot of focus when setting the start and endpoint with the time picker. To delete or edit an activity two users found it very easy and one user found it easy.

There was a problem however with one user in Norway using the *Plan* page in the *Remote Assistant* application where the page seemed to freeze when performing the task to mark an activity as complete. However, the other users found the task very easy.

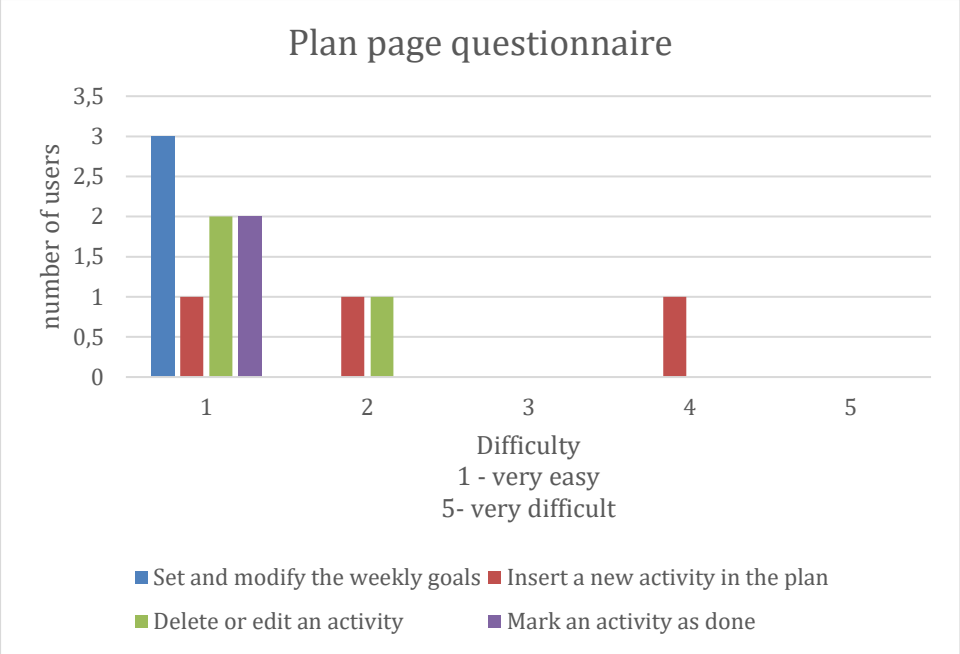


*Figure 25 — Tasks performed in the Plan page rated by difficulty*

## 7.3 Discussion

Given the small number of participants, it is difficult to have a good appraisal of how the notifications work as persuasive methods. Since the users in Norway did not feel compelled to increase their activity levels when receiving the messages, it could also indicate that there is more work to be done regarding the content of the persuasive messages.

Regarding the user in Norway who commented that sometimes he would receive a message praising him for doing hard psychical work incorrectly, this can result from a difference in what *Fitbit* associates to hard psychical activity and what the user perceives to be a hard activity. Some more work on how to parse *Fitbit*'s information can be done.

It also occurred that we were not informed until the end of the trials that the participant in Switzerland was not able to receive the persuasive messages. However, the messages for all users were indeed being generated and stored in the database and, consequently, being sent to the *Adaptation Engine*, so the technical part of the system was working correctly.

There were also periods of time during the tests where the PersonAAL servers were down, not allowing the *Persuasion Module* to access the *Context Manager* and, consequently, making its execution impossible.

Although the *Remote Assistant* application was previously tested in several computers, some errors reported by the test users in Norway could not be replicated by either us or the partners in Italy, also responsible for the application, which did not allow for a swift response in correcting said errors.

But even with these problems, the users seemed to find the tasks easy to perform (with the exception of adding a new activity in the *Plan* page for one user), which shows that if the bugs had been fixed, their appreciation of the system would be even more positive.

# Chapter 8

# Conclusion

In this final chapter will be presented an overall appreciation of the project, including how the goals stated in the first chapter were met, the difficulties encountered, how certain aspects could have been dealt with, how some mistakes could be avoided and what can still be improved.

## 8.1 Critical analysis

The research done for the chapter 2 (Related Work) gave an overview of technology already implemented in the field of fighting social isolation in the elderly population, allowing to see the different techniques used, its advantages and shortcomings. This literature plus the various meeting with the psychologists that were part of this project, allowed to meet the goal, established in the first chapter, of identifying social techniques that could be adapted in the context of the PersonAAL project. Another important part of the research went to explore ways to retrieve information about the user's social life, where the application *Purple Robot* was discovered and deemed the one with the right characteristics to be used in the project, thus meeting its goal. Although ultimately it ended up not being used due to the sensitive nature of the data retrieved and worries with the users' data protection, it allowed for the exploration of new sources of user data and the possibilities of new rules using that data. For example, it would be possible, based on the user's call and message logs to create rules that, if the user had not received or made calls/messages in a determined period of time, a notification could be sent with a message to encourage him to initiate some sort of social contact. Ultimately, this kind of messages could be sent to

some of the user's contacts for them to initiate the social exchange, if the user does not do it.

Other techniques were chosen to be implemented in the *Persuasion Module* through a new set of rules created in partnership with psychologists, where the data used to trigger the rules would be retrieved from various components of the PersonAAL platform namely the *Context Manager* and the *Remote Assistant* application. This information was then used to trigger the rules, generating a persuasive message and received by the users meeting the goal of implementing social techniques and allowing the user to receive personalised messages.

These rules, created with the goal to increase the user's social and physical activity, focused not only on the user's past activities, but also in his future activities planned through a calendar in the *Plan* page. To implement these rules, some changes were made to the *Remote Assistant* application, so that more information could be used by the *Persuasion Module*. Besides assembling all the user's data present in the *Remote Assistant* into the *Context Manager*, the *Plan* page needed a calendar that could support the creation of different types of activities, as well as be able to select the start and end time of said activities.

Similarly, the changes made in the *Persuasion Module* had to be implemented due to increasing complexity of the rules created and the addition of different sources of data and data formats, meeting the goal of modifying the *Persuasion Module* and the *Remote Assistant* application to implement the chosen social techniques.

The trials showed that while the changes in the *Remote Assistant* application and the *Persuasion Module* were correctly integrated in the existing platform, there is still work to be done regarding some aspects. The limited number of test users did not permit a broader view of the effect the persuasive messages can have.

It is very important to guarantee that the users are able receive the persuasion notifications in the device of their choice. One complaint of one of the users was that he would like to receive the messages on his cell phone, but only had the notification application installed on his tablet which he would not carry around.

This project allowed to show the *Persuasion Module*'s flexibility in terms of adding new rules, create new persuasive messages and use different sources of data to trigger said rules. As the data is processed inside the rule file, and the data source is

stored in the database, the process to create a new rule is simplified allowing to increase the rules complexity.

## 8.2 Future work

As mentioned in the previous section, there are components that require more work and there is ample space for improvement both in the *Remote Assistant* application as well as in the *Persuasion Module*.

To continue using messages as persuasive methods, it's important to work closely with the elderly and understand what type of messages would work better in persuading the users to increase their physical and social activities and if it is necessary to retrieve more information regarding the user's life to better adapt the message's content.

In the *Remote Assistant* application, to promote more social interaction between the users, a message exchange feature could be implemented. Besides providing the user with another mean to communicate with family, friends or caretakers, it could also be used to monitor social activity. That information could then be used to create new rules which would be implemented in the *Persuasion Module*.

A possible new feature regarding the persuasive messages would be making them more interactive. Besides serving as tool to inform, remind, make suggestions and motivate the user, the messages shown could, for example, also inquire if the user plans to follow the *Persuasive Module*'s suggestion of inviting someone for a training session, or if the user will participate in his scheduled activities that the message is currently reminding him of.

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# Apendixes

Apendix A – Purple Robot's available probes

| Category | Probe | Description |
|---|---|---|
| **Hardware Sensor Probes** | Accelerometer | Measures the acceleration applied to the device. All values are in SI units (m/s^2). |
| | Gyroscope Probe | Measures angular speed around each axis. |
| | Light Probe | Detects the ambient light level in SI lux units. |
| | Location Probe | Records the most accurate location available for the device, given device limitations and respecting battery life. |
| | Magnetic Field Probe | Detects the local magnetic field. Can be used as to detect the earth's magnetic field, but may be distorted by metal objects around the device. |
| | Pressure Probe | Records the pressure on the touch screen of the device. |
| | Proximity Probe | How far the front of the device is from an object |
| | Temperature Probe | Used to record temperature. |
| | Audio Features Probe | Extracts information about the audible environment at regular intervals. |
| | Accelerometer Statistics | Provides basic descriptive statistics for incoming accelerometer sensor data. |
| | Gyroscope Statistics | Provides basic descriptive statistics for |

| | | |
|---|---|---|
| | | incoming gyroscope sensor data. |
| | Magnetic Field Statistics | Provides basic descriptive statistics for incoming gyroscope sensor data. |
| | Light Sensor Statistics | Provides basic descriptive statistics for incoming light sensor data. |
| | Pressure Sensor Statistics | Provides basic descriptive statistics for incoming pressure sensor data. |
| | Proximity Sensor Statistics | Provides basic descriptive statistics for incoming proximity sensor data. |
| | Temperature Sensor Statistics | Provides basic descriptive statistics for incoming temperature sensor data. |
| | Near Field Communications Probe | Generates readings when NFC tags are scanned. |
| | Accelerometer Frequencies | Provides basic frequency analyses for incoming accelerometer data. |
| | Gravity Probe | Measures the gravitational force applied to the device. All values are in SI units (m/s^2). |
| | Step Counter Probe | Counts the number of steps taken since the last restart. |
| | Linear Acceleration Probe | Measures the acceleration applied to the device (minus the gravity). All values are in SI units (m/s^2). |
| | Rotation Vector Probe | Measures the orientation of the device as a combination of an angle and an axis, in which the device has rotated through an angle ϕ around the axis [x,y,z]. |
| | Geomagnetic Rotation Vector Probe | Identical to the rotation vector probe, but uses a magnetometer instead of using a gyroscope. This uses less power than the probe, because it doesn't use the gyroscope. However, it is noisier and will work best outdoors. |

| | | |
|---|---|---|
| | Ambient Humidity Probe | Used to record ambient humidity. |
| | Significant Motion Probe | Generates an event when the device detects sudden motion. |
| | Fused Location Probe | Location probe using Google Play Services' location. |
| | Accelerometer Sensor Probe | Measures the acceleration applied to the device. All values are in SI units (m/s^2). |
| | Light Sensor Probe | Detects the ambient light level in SI lux units. |
| **Device Information & Configuration Probes** | Battery Probe | Information about the type and current state of the battery in the device. |
| | Current Call State | Observes whether the mobile phone is idle or in use. |
| | Hardware Information Probe | Details about the specific hardware the device is running, including component identifiers. |
| | Network Configuration Probe | Current network configurations of the active interface. |
| | Purple Robot Health | Summarizes the current state of the Purple Robot app, including the armor of data to be transmitted to the server. |
| | Running Software Probe | Details about the apps the device is currently running. |
| | Screen Probe | Records when the screen turns off and on. |
| | Software Information | Collects information about software installed and running on the current device. |
| | Telephony Probe | Records telephony hardware, software and account information. |
| | Application Launch Events | Details about the apps the device is currently running. |
| | Device In Use | Indicates whether the device is in use. |

| | | |
|---|---|---|
| | Wake Lock Information | Reports details about wake locks that affect power management and efficiency. |
| **External Device Probes** | Visible Bluetooth Probe | Detects Bluetooth devices within range. |
| | WiFi Probe | Records available wireless (WiFi) access points and relevant connection information. |
| | Media Router Probe | Discovers available media routers (such as Chromecast devices). |
| | Pebble Watch | Collects data from a Pebble smartwatch. |
| | Android Wear Probe | Retrieves sensor data from a connected Android Wear device. |
| **External Environment Probes** | Visible Satellites | Observes visible GPS satellites to help determine location, cloud cover and other information. |
| | Sunrise & Sunset Feature | Calculates whether it is day or night and the times for sunrise and sunset. |
| **Personal Information Probes** | Significant Location Distances Sensor | Calculates the distance from significant locations in the local address book. |
| | Call & Message Info | Generates statistics and counts about phone, SMS, and other communication uses. |
| | Communication Events Probe | Logs phone calls and text messages as sensor events. |
| | Date Calendar Sensor | Records basic information from the local calendar, including elements like the day of the week, week of the month, month of the year, etc… |
| | Call History Statistics | Generates aggregate statistics that describe the user's phone call activity, include counts of daily calls. |
| **External Services Probes** | iHealth | Retrieves information from the your online iHealth profile. |
| | Fitbit | Retrieves information from your online Jawbone profile. |

| | | |
|---|---|---|
| | Jawbone | Retrieves information from your online Fitbit profile. |
| | GitHub | Retrieves activity data from your GitHub account. |
| | Twitter | Collects profile data & posts from Twitter |
| | Instagram | Collects profile data & posts from Instagram |
| | Foursquare | Collects activity from Foursquare as well as names for current locations. |
| | Google Places | Count the number of nearby location types |
| | Weather Underground | Acquires the latest weather data for the user's location from a nearby Weather Underground station |
| **Miscellaneous Probes** | Random Noise Probe | Generates random floating point numbers at a 4Hz frequency for diagnostic purposes. |
| | Activity Detection Probe | Uses Google Play services to categorize the user's activity based on sensor readings |
| | Raw Location Probe (Beta) | Variation of the location probe, but with battery conservation functionality removed for testing purposes |
| | Shion Probe | Fetches device information from a Shion home automation deployment |
| | SAINT Probe | Fetches data collected & predicted by the SAINT sensing & activity recognition library |
| | Touch Events Probe | Captures data about user touch interactions |
| **Study-Specific Probes** | Livewell Phone Activity Counts | Collects activity count data from local device. |
| | Livewell Pebble Activity Counts | Collects activity count data from a Pebble smartwatch running the Livewell watchface. |
| **Media Capture and Recording Probes** | Audio Capture Probe | Periodically creates a recording of the audio environment. |
| **Beta & Testing Probes** | Fitbit (Beta) | Retrieves information from your online Fitbit profile. This is a beta probe and should not be used in production capacities |

Apendix B – Rules created for the Persuasion Module

| Domain | Name | Trigger 1 | Trigger 2 | Message 1 | Message 2 (Option) | Message 3 (Option) |
|---|---|---|---|---|---|---|
| Physical - Exercise | More Steps than Typical Day | Yesterday Steps (fitbit) > Average day steps (average from fitbit last 7 days) | 8h00 | Yesterday you walked X more steps than a typical day. (Rational) | Hurray! Yesterday your step count was great! (Motivational) | |
| Physical - Exercise | Less Steps than Typical Day | yesterday steps (fitbit) < 0,8 * Average day steps (average from fitbit last 7 days) | 8h00 | Yesterday you walked X less steps than a typical day. (Rational) | | |
| Physical - Exercise | Exercise Reminder | Every day (X= reported completed exercise activities RA) (Y= RA weekly goal) | 8h00 | Yesterday you exercised X minutes of your weekly goal of Y hours. (Rational) | | |
| Physical - Pulse | 70 max pulse | If X > 10 (X=Fitbit veryActive + fairlyActive minutes yesterday) | 8h00 | Yesterday you spent X minutes doing intense physical activity. (Rational) | YES! Yesterday you did a lot of hard physical activity! (Motivational) | Yesterday you met your goal about doing hard physical activity for X minutes. (Rational) |
| Physical - Step | More Exercise Last Week | last week active minutes (reported completed exercise activities RA) > last week exercise minutes goal (from RA goals) | 8h00 | Last week you performed more exercise than what you had planned! (Rational) | Hurray! Last week, you did very well! (Motivational) | |
| Physical - Step | Almost Exercise Last Week | last week active minutes (reported completed exercise activities RA) > | 8h00 | Last week you were really close to reaching your goal! | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 79% last week exercise minutes goal && < last week exercise minutes goal (from RA goals) | | (Motivational) | | |
| Physical - Step | Invite to Exercise | Planned physical activity today (RA calendar) (Walk) done == 0 | 12h00 | What about inviting someone for a walk today? (Social) | | |
| Physical - Step | Report Exercise | Reported physical activity previous day (RA calendar) \|\| Fitbit cardio minutes > 10 | 11h00 | Why not send a message to Anne-Marthe to tell about the exercise you did yesterday? (Social) | Why not tell someone about yesterday's activities? (Social) | |
| Physical - Step | Reached Goal Week | today + last 6 days exercise minutes (completed activities) => week exercise minutes goal (RA) | 19h00 | You reached this week exercise goal! (Motivational) | | |
| Social - Activity | Invite to Train | Fitbit fairly active minutes (yesterday) > 29 && plannedActivity(RA)=true | 7h00 | What about inviting someone for a training session? (Social) | | |
| Physical - Pulse | Harder than Usual | Fibit very active activity minutes yesterday > average day (average from last 7 days from fitbit) | 9h00 | Great job! Yesterday you worked out harder than usual! (Motivational) | | |
| Physical - Pulse | More than Usual | Fibit fairly activity minutes yesterday > average day (average from last 7 days from fitbit) | 9h00 | Great job! Yesterday you worked out more than usual! (Motivational) | Why not tell someone about yesterday's activities? (Social) | Why not call Anne-Marthe to share the kind of activities you did yesterday? (Social) |
| Social - Events | Invite to Social | Planned social event (today) (from context | 7h00 | What about inviting someone to go with you | Why don't you ask someone to go with | You have planned for (NAME OF ACTIVITY) |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | manager) AND social event type in (cinema,teather, restaurante, pub, religious, other) | | to your planned social activity today? (Social) | you? (Social) | today. Do you want to invite someone to join you? YES NO (Motivational) |
| Social - Events | Social Reminder | Planned social event (today) AND not reported (from RA) end_time > current_time | 15h00 | You have a planned activty today. Don't you want to go? (Social) | | |
| Physical - Step | Half Goal Reached | 0.60* weekly exercise minutes goal > this week active minutes (completed activities) > 0.51 * weekly exercise minutes goal | 17h00 | You have reached half of your exercise goal for this week! (Rational) | | |
| Physical - Step | Almost Goal Reached | weekly exercise minutes goal > this week active minutes (completed activities) > 0.80 * weekly exercise minutes goal | 18h00 | You have almost reached your exercise goal for this week! (Motivational) | You are close to reaching this weeks' step goal. Keep on doing the great job! (Motivational) | |
| RA - Specific | Fill goal section | If the person has not filled out the goal section | Every couple of days (Monday, Wednesday, Friday) 10h00 | Hi! To keep track of your health-status, the goal survey at the "plan"-page needs to be filled out. You should do it now. (Motivational) | | |
| Social - Events | Morning Social Reminder | Planned social activity (today) (from RA) | 7h00 | Remember that you have planned a social activity today: <intensity>. (Rational) | | |
| Physical - | Morning | Planned step activity | 7h00 | Remember that you | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Steps | Walk Reminder | (today) | | have planned to go walk (NUMBER OF STEPS) today. (Rational) | | |
| Physical - Exercise | Morning Exercise Reminder | Planned exercise activity (today) | 7h00 | Remember that you have planned to work out today at (HOUR OF PLANNED EVENT). (Rational) | | |
| RA - Specific | Access plan page | last access to plan page (RA) | 19h00 | Remember to mark your completed activities in the Remote Assistant's plan page | | |
| RA - Specific | Plan social activity reminder | nº of planned social activities + nº of completed social activities < social goal | 16h00 | To meet your social goals for this week, remember to plan for more social activities. Maybe you can do it now? | To meet your social goals for this week, remember to plan for more social activities | |
| RA - Specific | Plan exercise activity reminder | duration of planned exercise activities + duration of completed exercise activities < exersice goals | 16h00 | To meet your exercise goals for this week, remember to plan for more of exercise. Maybe you can do it now? | To meet your exercise goals for this week, remember to plan for more of exercise. | |

Apendix C – Field trial questionnaires

# Norwegian Results of the Questionnaire

On the use and benefits of PersonAAL

# Remote Assistant Application

**SIGN-IN**


1) How easy did you find log-in to the application?

| **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|
| ○ xx | ○ | ○ | ○ | ○ |

2) How easy did you find select your language?

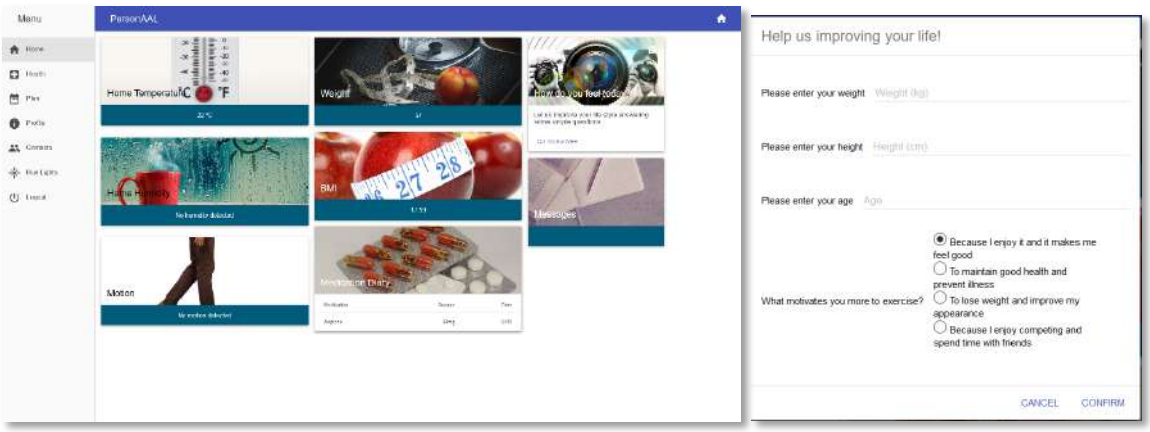
| **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|
| ○ x | ○ | ○ x | ○ | ○ |

3) Do you have any suggestions for improving the sign-in page?

Yes ☐ No XX

If Yes, please note them here:

**HOME**




4) How easy did you find completing the survey?

| **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|
| ○ | ○ XX | ○ | ○ | ○ |

If You have comments on the survey, please note them here:

| |
|---|
| |

5) How useful did you find the information visualized in the Home page?

| | **Very useful 1** | **2** | **3** | **4** | **Very unuseful 5** |
|---|---|---|---|---|---|
| Home Temperature | ○ X | ○ | ○ | ○ | ○ X |
| Home Humidity | ○ | ○ | ○ | ○ | ○ X (+ 1 NA) |
| Motion | ○ | ○ | ○ | ○ X (+ 1 NA) | ○ |
| Weight | ○ | ○ X | X ○ | ○ | ○ |
| BMI | ○ | ○ X | ○ X | ○ | ○ |
| Medication Diary | ○ | ○ X | ○ | ○ | X ○ |

If You have comments, please note them here:

| |
|---|
| |

6) Do you have any suggestions for additional environment sensors to include in the kit?

Yes ☐ No XX

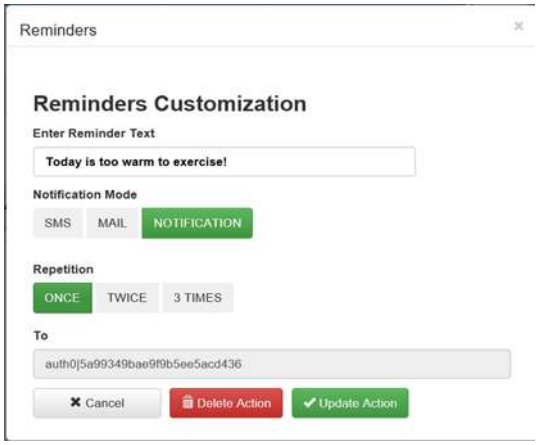
If Yes, please note them here:

| |
|---|
| |

7) Were you able to edit some rule to visualize a reminder message?

For example:

***IF*** *Temperature is (condition) more than 25 °C ,* ***DO*** *send reminder by notification to {myUserID}*




Yes XX No ☐

8) Did it work as expected?

Yes [X] No [X]

If No, please explain (which rule did you try to edit? what you expected?):

| |
|---|
| Tried to send it to my phone. Did not work due to security.<br>When trying to connect to rules regarding position: Position check needs carrying the tablet. |

9) Do you have any suggestions for improving the Home page?

Yes [ ] No [XX]

If Yes, please note them here:

| |
|---|
| |

**HEALTH**


10) How easy did you find visualize the Respiration Rate and Heart Rate real time graphs?

| **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|
| ○ X | ○ X | ○ | ○ | ○ |

If You have comments, please note them here:

Easy to find the pictures, but they didn't work. The results were 0. I were told where to find the pictures the first time.

11) How useful did you find the information visualized in the Health page?

| | **Very useful 1** | **2** | **3** | **4** | **Very unuseful 5** |
|---|---|---|---|---|---|
| Hearth Rate | ○ | ○ X | ○ | ○ | ○ X |
| Respiration Rate | ○ | ○ | ○ X | ○ | ○ X |
| Internal Temperature | ○ | ○ | ○ | ○ | ○ X |
| Position | ○ | ○ | ○ X | ○ | ○ X |

If You have comments on the information visualized, please note them here:

12) Do you have any suggestions for additional physiological sensors to include in the kit?

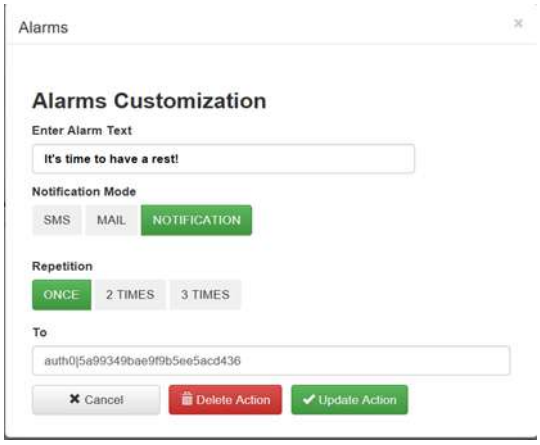
Yes ☐ No XX

If Yes, please note them here:

13) Were you able to edit some rule to visualize an alert message?

For example:

***IF*** *Heart Rate is (condition) more than 160 bpm* ***, DO*** *send a alarm by notification to {myUserID}*




Yes [XX] No [ ]

14) Did it work as expected?

Yes [XX] No [ ]

If No, please explain (which rule did you try to edit? what you expected?):

| |
|---|
| |

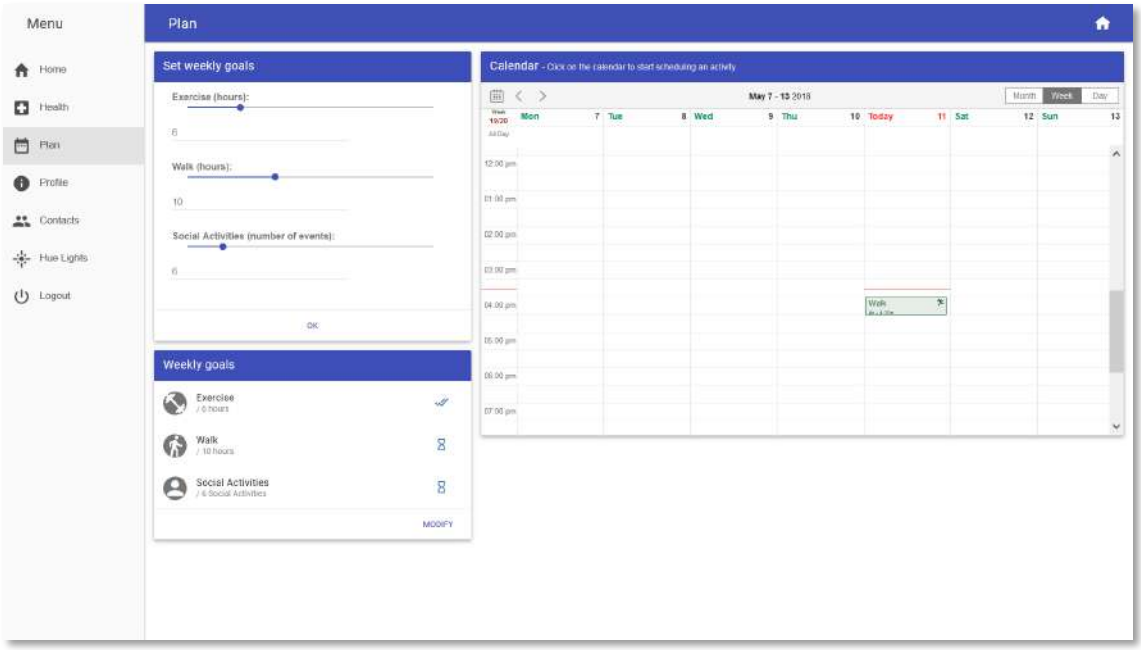
15) Do you have any suggestions for improving the Health page?

Yes [ ] No [XX]

If Yes, please note them here:

| |
|---|
| |

**PLAN**




16) How easy did you find performing the following operations?

| | **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|---|
| Set and modify the weekly goals | XX | | | | |
| Insert a new activity in the Plan | X | | | X | |
| Delete or Edit an activity | X | X | | | |
| Mark an activity as done | X | | | | |

If You have comments, please note them here:

It was a lot to focus on when adding a new activity, eg. PM/AM, make sure the starting point was mot set to be after the ending point. When aware of issues like this, it was ok, but it was cumbersome.

"Mark an activity as done" didn't work. Made the whole system freeze.

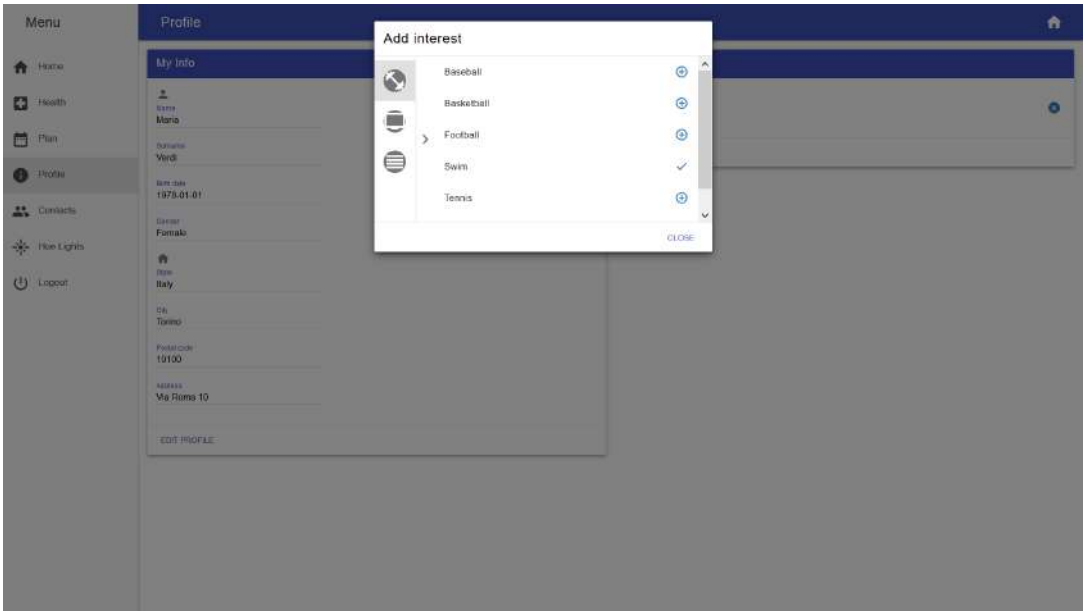
17) Do you have any suggestions for improving the Plan page?

Yes [X] No [X]

If Yes, please note them here:

Not nessesary to have both a weekly planner and a weekly calendar. Suggests deleting the "Weekly planner"

**PROFILE**




18) How easy did you find performing the following operations?

| | **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|---|
| Update Profile | ○ X X | ○ | ○ | ○ | ○ |
| Add Interests | ○ X | ○ | X ○ | ○ | ○ |

If You have comments, please note them here:

Difficult to get the program to work when pushing the + sign.

19) Do you have any suggestions for improving the Profile page?

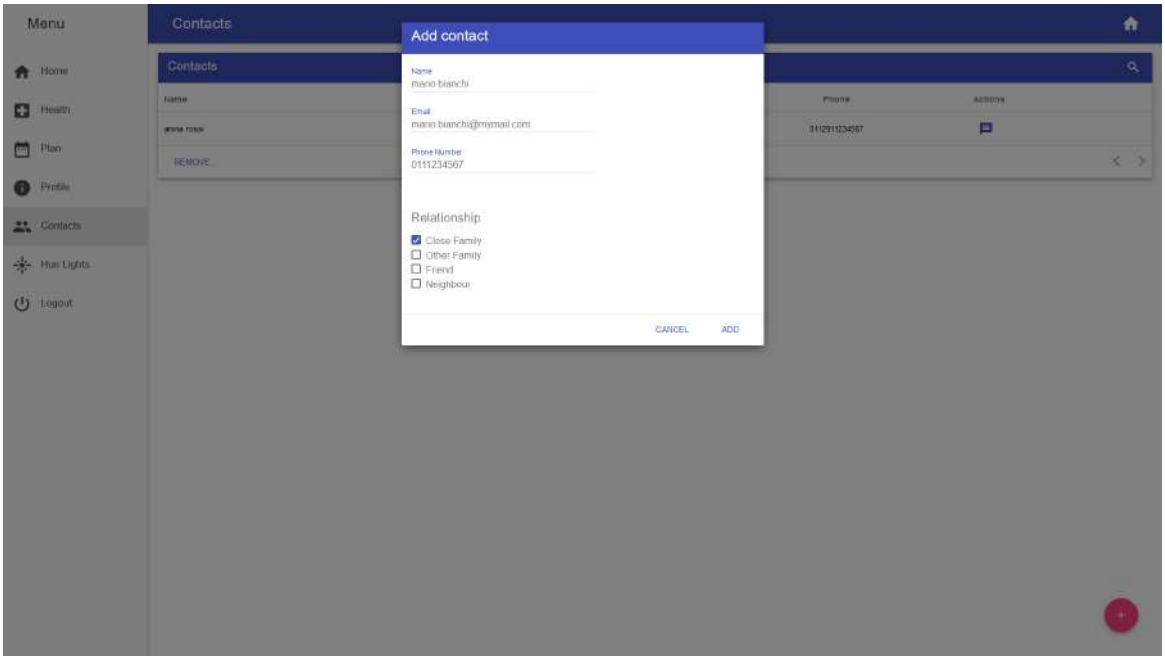
Yes [X] No [X]

If Yes, please note them here:

| |
|---|
| The screen has to work when in use. |

## CONTACTS

20) How easy did you find performing the following operations?




| | Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|---|
| Add Contacts | xx | | | | |
| Delete Contacts | xx | | | | |

If You have comments, please note them here:

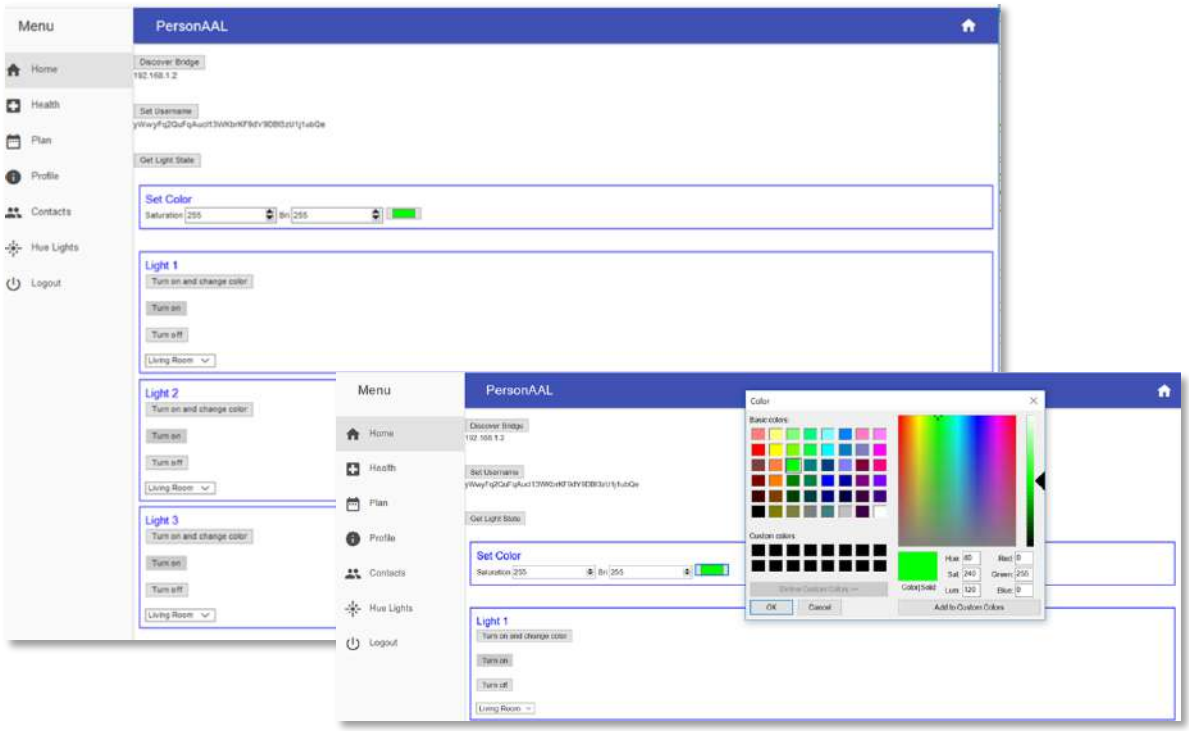
| |
|---|
| But the screen didn't always work |

21) Do you have any suggestions for improving the Contacts page?

Yes ☐ No XX

If Yes, please note them here:

**HUE LIGHTS**




22) How easy did you find performing the following operations?

(Please use Firefox with Security flag disabled)

| | **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|---|
| Discover Bridge | xx | | | | |
| Set Username | | x | | x | |
| Get Light State | | x | | x | |
| Turn on/off/change color to lamp | | xx | | | |

If You have comments, please note them here:

Had to be told that I had to push the Bridge

Became unstable during the testing

23) Were you able to edit some rule to change the Hue Lights status?

For example:
*IF Time is after 22:00 **AND WHEN** Motion becomes true , **DO** Turn On and set color light Living Room color to White for 2 minutes*

Yes [XX] No [ ]

24) Did it work as expected?

Yes [XX] No [ ]

If No, please explain (which rule did you try to edit? what you expected?):

But sometimes with a suprising result. When I tested the system with too high puls, the light for body-position went on.

Unstable, explained as change of security certificates.

25) Do you have any suggestions for improving the Hue Lights page?

Yes [ ] No [XX]

If Yes, please note them here:

26) Do you have any suggestions for additional appliances to control with rules?

Yes [ ] No [XX]

If Yes, please note them here:

**GENERAL**

27) Which of the functionalities available is most useful to you?

Light and motion detection

I don’t know. Maybe the weekly planner.

28) Which additional feature do you think it would be useful?

Eg. Blood-pressure measurement

29) If this application would be available at no cost, do you think you would use it?

Yes ☐ No x

If you answered No could you please explain why?

Not today, but maybe later, when my health deteriorates.

# Persuasive Notifications

30) Did you find useful to receive persuasive notifications on your tablet?

Yes ☐ No xx

Could you please describe some reasons why?

Sometimes I received messages with wrong content saying I did hard physical workout yesterday. I need other things to get motivated.

I didn't use the tablet regularly enough.

31) Do you think receiving these notifications can increase your physical activity levels?

Yes ☐ No xx

Could you please describe some reasons why?

Too lazy

I didn't work out more or harder due to them

32) Do you think receiving these notifications can increase your social activity levels?

Yes ☐ No xx

Could you please describe some reasons why?

These types of messages don't get me to eg. go to meetings with other retired people.

Not at the present time.

33) Was the frequency of the notifications appropriate?

Yes ☐ No xx

If not, would you like to receive more or was it annoying?

Sometimes they were just annoying. Wanted less messages.

Only as amusement

34) Was the content of the notifications appropriate?

Yes x No x

If not, why?

Sometimes, even though I had not worked out, maybe just did some walking, but still I received praising for doing hard physical workout.

# Chestband

## CHESTBAND

35) How easy was it to place the chestband on your chest?

| Very easy<br>1 | 2 | 3 | 4 | Very difficult<br>5 |
|---|---|---|---|---|
| ○ x | ○ x | ○ | ○ | ○ |

36) Was the chestband comfortable to use?

| Very Comfortable<br>1 | 2 | 3 | 4 | Very discomfortable<br>5 |
|---|---|---|---|---|
| ○ | ○ x | ○ | ○ x | ○ |

37) Did you experience any difficulties attaching the hub snaps to the band?

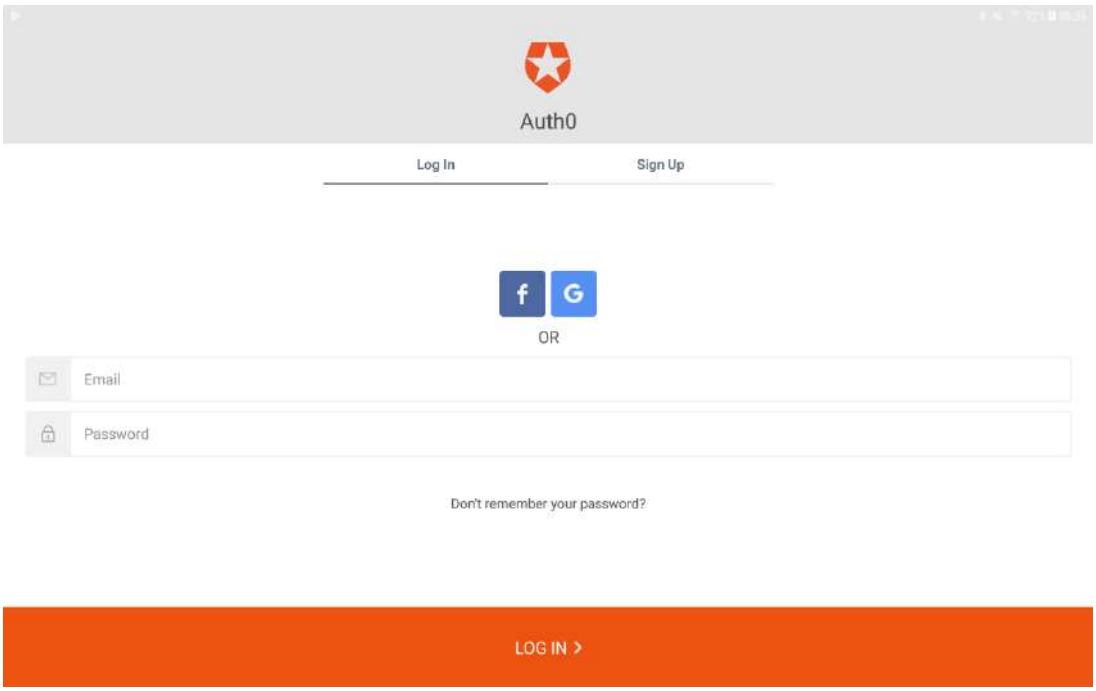
**Yes** [ ] **No** [XX]

38) Do you have any suggestions for improving the chestband form factor?

**Yes** [ ] **No** [XX]

One of the buttons fell off.

If Yes, please note them here:




## CHESTBAND'S CONTEXT DELEGATE

### SIGN-IN

39) How easy did you find logging-in to the application?

| Very easy<br>1 | 2 | 3 | 4 | Very difficult<br>5 |
|---|---|---|---|---|
| X | | | X | |

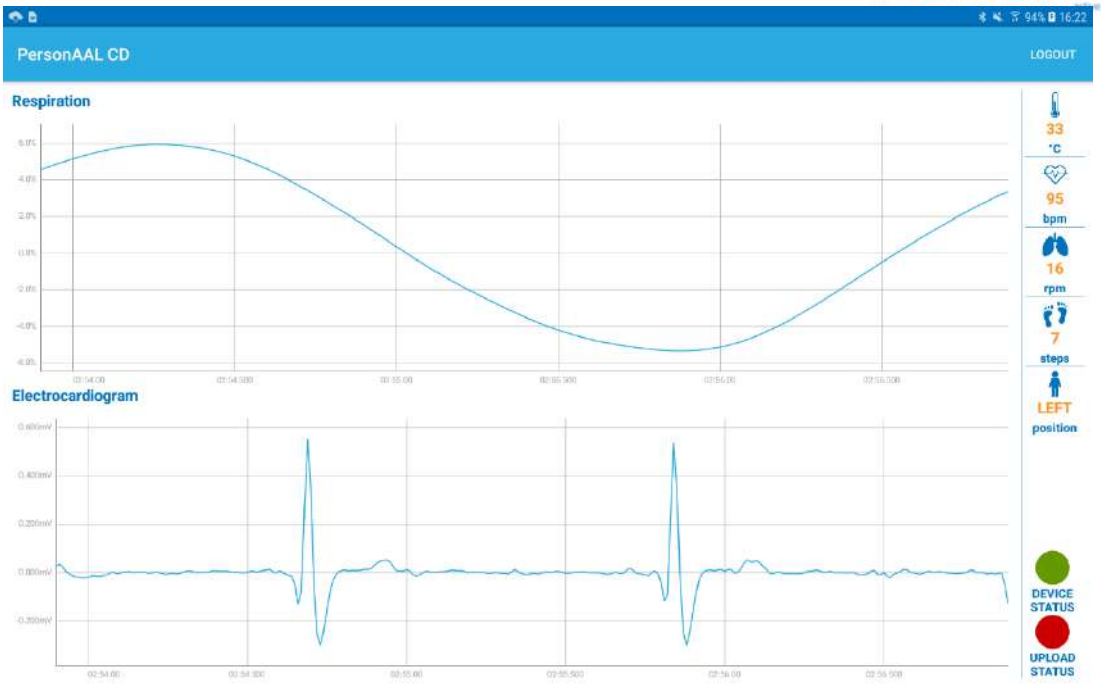
40) Do you have any suggestions for improving this view?

| |
|---|
| Had to be told more than once where to find it |

**Yes** [X] **No** [ ]

If Yes, please note them here:

specify in the name of the app what it is, eg. "puls-measurement"




**DATA DISPLAY**

41) How easy was it to understand the interface?

| Very easy<br>1 | 2 | 3 | 4 | Very difficult<br>5 |
|---|---|---|---|---|
| X | | | X | |

42) How useful did you find the extracted values displayed on the right side of the screen?

| Very useful<br>1 | 2 | 3 | 4 | Very Unuseful<br>5 |
|---|---|---|---|---|
| | XX | | | |

43) Were the values responsive, meaning, did they update properly?

| Always<br>1 | 2 | 3 | 4 | Never<br>5 |
|---|---|---|---|---|
| X | | | | X |

* APART FROM THE TEMP: -273 c

44) How useful did you find the informative states (device and upload) displayed on the right bottom side of the screen?

| Very useful<br>1 | 2 | 3 | 4 | Unuseful<br>5 |
|---|---|---|---|---|
| | X | X | | |

| | | | | |
|---|---|---|---|---|
| | | | | |

45) Did you use the context delegate as an aid to correctly place the chestband?

**Yes** [ ] **No** [XX]

46) Do you have any suggestions for improving the Display Data view?

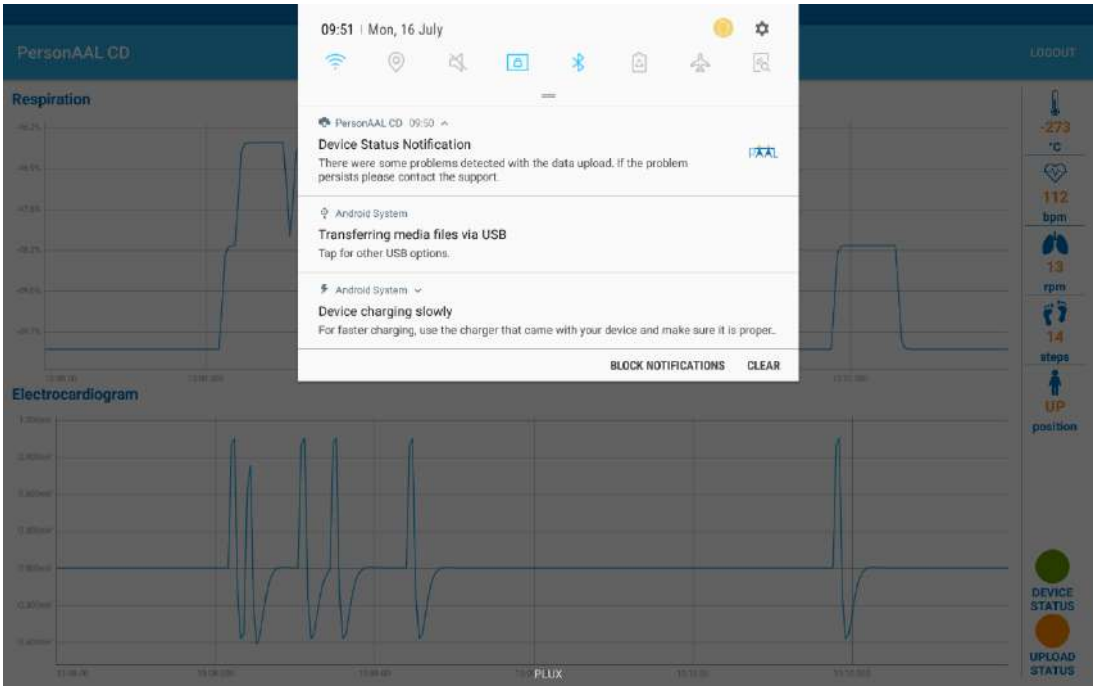
That the data on right hand side becomes correct.

(not a clear image. Lots of noise)

**Yes** [X] **No** [X]

If Yes, please note them here:

**NOTIFICATIONS**

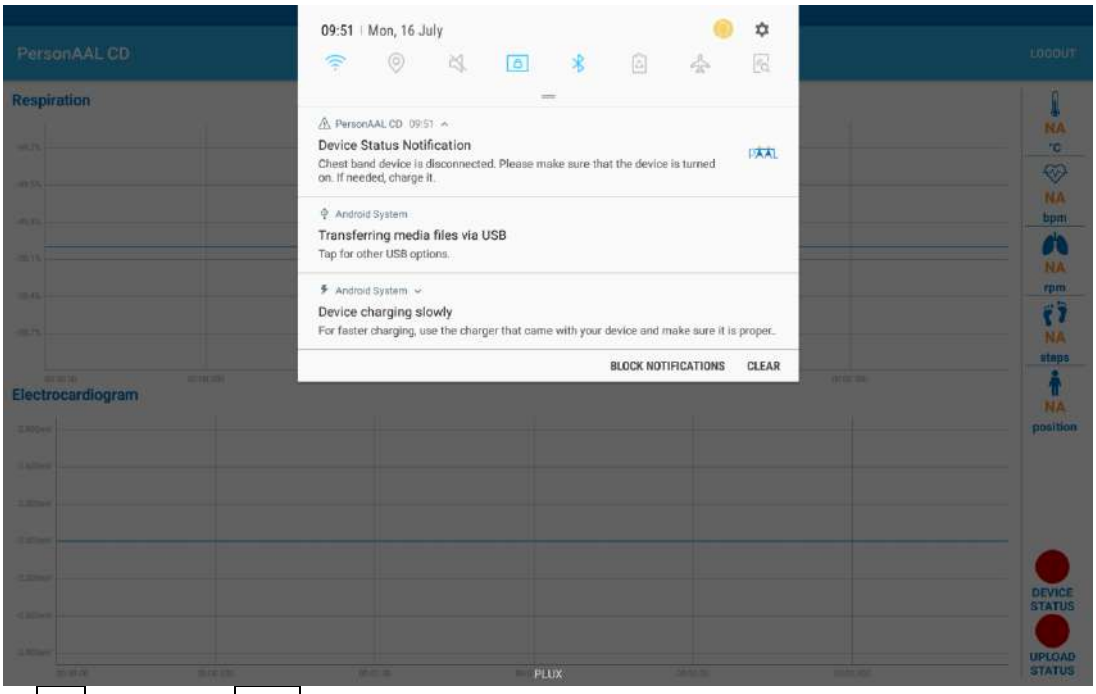



**Data Upload Notification**

47) How often was this notification shown?

| Never | Once a day | Twice a day | More than 2 times a day | Always |
|---|---|---|---|---|
| ○ X | ○ | ○ | ○ | ○ X |

48) Did you find this notification useful?




**Yes** [ ] **No** [XX]

**Device Status Notification**

49) How often was this notification shown?

| Never | Once a day | Twice a day | More than 2 times a day | Always |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ X |

* Always after I had taken of the chest-band *sometimes

50) Did you find this notification useful?

**Yes** [X] **No** [X]

51) Do you have any suggestions of data or information that you would like to be notified of by the context delegate?

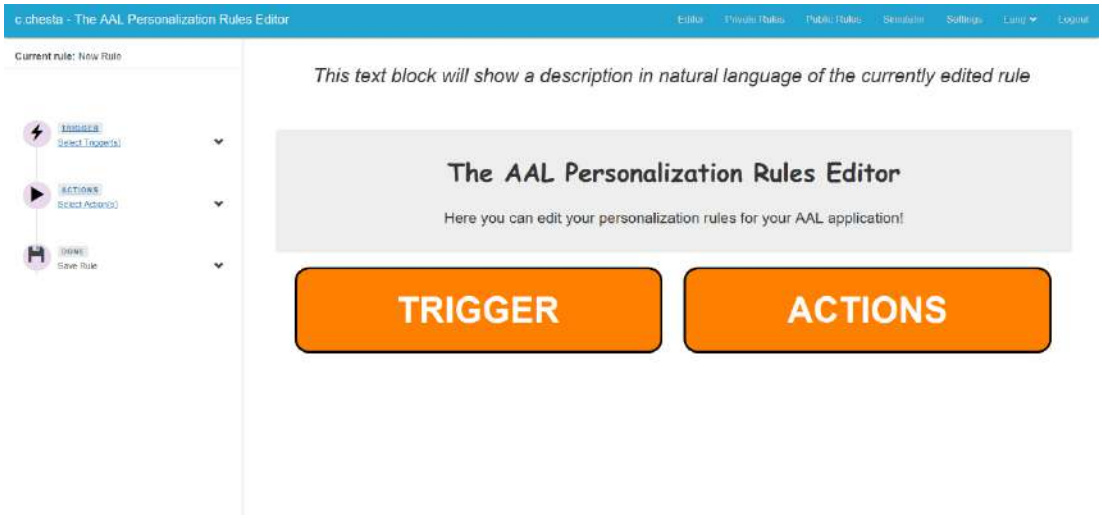
**Yes** [X] **No** [X]

Blood-pressure

If Yes, please note them here:

# Authoring Tool

**RULES EDITOR**




52) How often did you use the Rules Editor?

| Never | Once | Sometimes | Often | Every Day |
|---|---|---|---|---|
| ○ | ○ | ○ xx | ○ | ○ |

53) How did you find it easy to use the editor?

| Very easy | Needed help only to start | Needed help sometimes | Needed help often | Very Difficult |
|---|---|---|---|---|
| ○ | ○ x | ○ | ○ x | ○ |

54) Which functionalities of the rule editor did you find most useful?

| | Very useful 1 | 2 | 3 | 4 | Very unuseful 5 |
|---|---|---|---|---|---|
| Editor | ○ xx | ○ | ○ | ○ | ○ |
| Private Rules | ○ xx | ○ | ○ | ○ | ○ |
| Public Rules | ○ | ○ | xx ○ | ○ | ○ |
| Simulator | ○ | ○ | ○ | ○ | x ○ |
| Side Map | ○ xx | ○ | ○ | ○ | ○ |

55) Do you have any suggestions for additional functionalities?

**Yes** [ ] **No** [XX]

| |
|---|
| |

If Yes, please note them here:

56) Have you added new rules with the rule editor?

**Yes** [**XX**] **No** [ ]

If Yes, have you achieved the results you wanted with these new rules?

| |
|---|
| It varied. When things were working, yes. Very often they didn't work. It didn't work when I tested the Becons (position), both combined with lights and alarm.<br>Yes, but the editing and creation of rules need a level of experience. |

If No, did you try to define any additional rule, which did not succeed? Please explain.

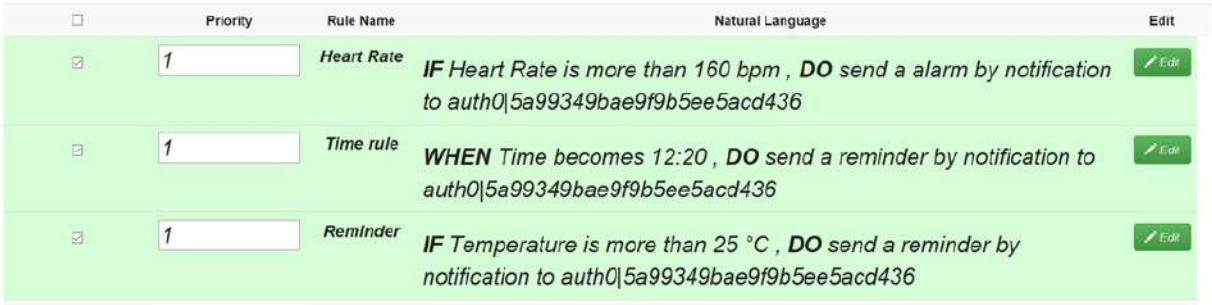
57) How do you rate the usability of the tool support for reusing previously saved rules?

| **Very bad 1** | **2** | **3** | **4** | **Very good 5** |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ X | ○ X |

58) How do you rate the usability of the tool support for saving and applying rules?

| **Very bad 1** | **2** | **3** | **4** | **Very good 5** |
|---|---|---|---|---|
| ○ | ○ | ○ X | ○ | ○ X |

**RULES**



| | Priority | Rule Name | Natural Language | Edit |
|---|---|---|---|---|
| ☑ | 1 | Heart Rate | **IF** Heart Rate is more than 160 bpm , **DO** send a alarm by notification to auth0\|5a99349bae9f9b5ee5acd436 | Edit |
| ☑ | 1 | Time rule | **WHEN** Time becomes 12:20 , **DO** send a reminder by notification to auth0\|5a99349bae9f9b5ee5acd436 | Edit |
| ☑ | 1 | Reminder | **IF** Temperature is more than 25 °C , **DO** send a reminder by notification to auth0\|5a99349bae9f9b5ee5acd436 | Edit |

59) Did you find intuitive the rules description in natural language provided by the tool?

**Yes** [XX] **No** [ ]

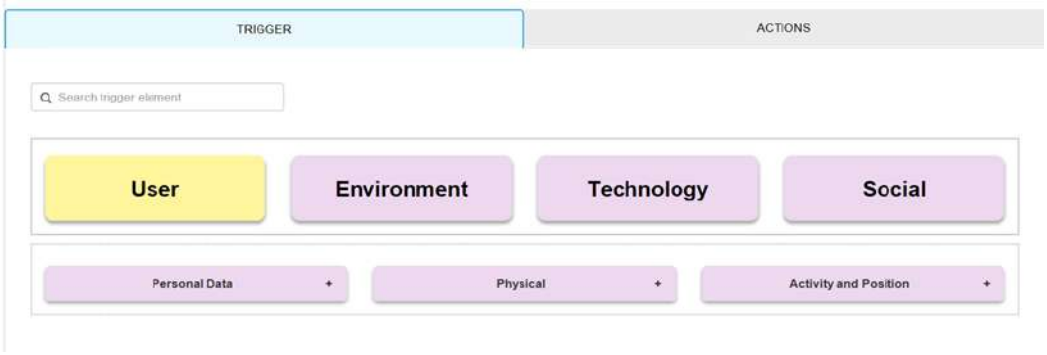
This probably demands that the user have used it before.

If No, please explain why:

60) How do you rate the usefulness of describing the rules in natural language?

| Very bad 1 | 2 | 3 | 4 | Very good 5 |
|---|---|---|---|---|
| ○ | ○ | ○ X | ○ X | ○ |

61) How do you rate the usability of the trigger selection mechanism supported by the tool?




| Very bad 1 | 2 | 3 | 4 | Very good 5 |
|---|---|---|---|---|
| ○ | ○ X | ○ | ○ | ○ X |

62) How do you rate the exhaustiveness of the set of events that can be specified with the tool?

| Very bad 1 | 2 | 3 | 4 | Very good 5 |
|---|---|---|---|---|
| ○ | ○ X | ○ X | ○ | ○ |

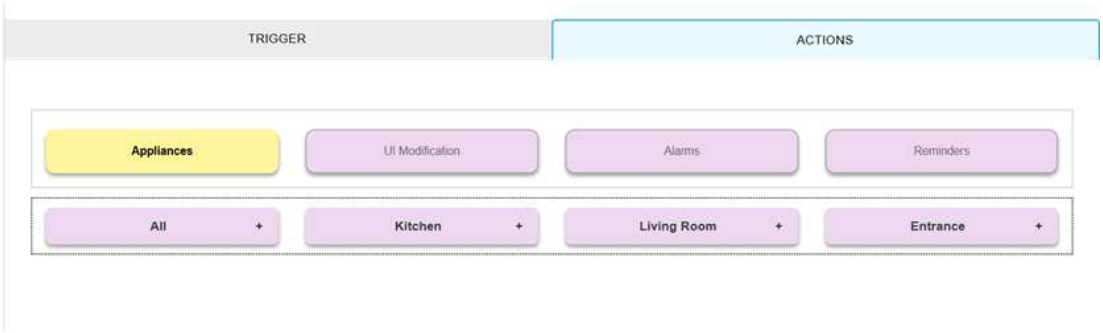
63) Do you have any suggestion to improve the hierarchy of events (e.g. elements to add/remove to/from the set of events)?

**Yes** ☐ **No** XX

| |
|---|
| |

If Yes, please note them here:

64) How do you rate the usability of the action selection mechanism supported by the tool?




| Very bad 1 | 2 | 3 | 4 | Very good 5 |
|---|---|---|---|---|
| ○ | ○ X | ○ | ○ X | ○ |

65) How do you rate the exhaustiveness of the set of actions that can be specified with the tool?

| Very bad 1 | 2 | 3 | 4 | Very good 5 |
|---|---|---|---|---|
| ○ | ○ X | ○ X | ○ | ○ |

66) Do you have any suggestion to improve the hierarchy of actions (e.g. elements to add/remove to/from the set of actions)?

**Yes** ☐ **No** ☒ XX

| |
|---|
| |

If Yes, please note them here:

**GENERAL**

67) Do you think that this approach is useful to make context-dependent an application?

**Yes** ☒ X **No** ☐

Please explain/motivate you answer:

68) Do you have any general suggestions to improve the Authoring Tool?

**Yes** ☐ **No** XX

If Yes, please note them here:

# Notification App



1) How easy did you find it to log-in to the App?

| | | | | |
|---|---|---|---|---|
| **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |

| | | | | |
|---|---|---|---|---|
| ○ XX | ○ | ○ | ○ | ○ |

1) How intuitive was the Notification App to use?

| **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|
| ○ X | ○ X | ○ | ○ | ○ |

1) Did you find the Notification App hard to use?

Yes ☐ No XX

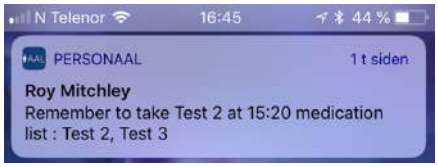
If Yes, please tell us what you found complicated and hard to understand:

2) Do you have any suggestions for improving the app?

Yes ☐ No XX

If Yes, please note them here:

1) Did you notice the messages when they arrived?



| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| X | | X | | |

1) Did you hear the sound message when the notification arrived?

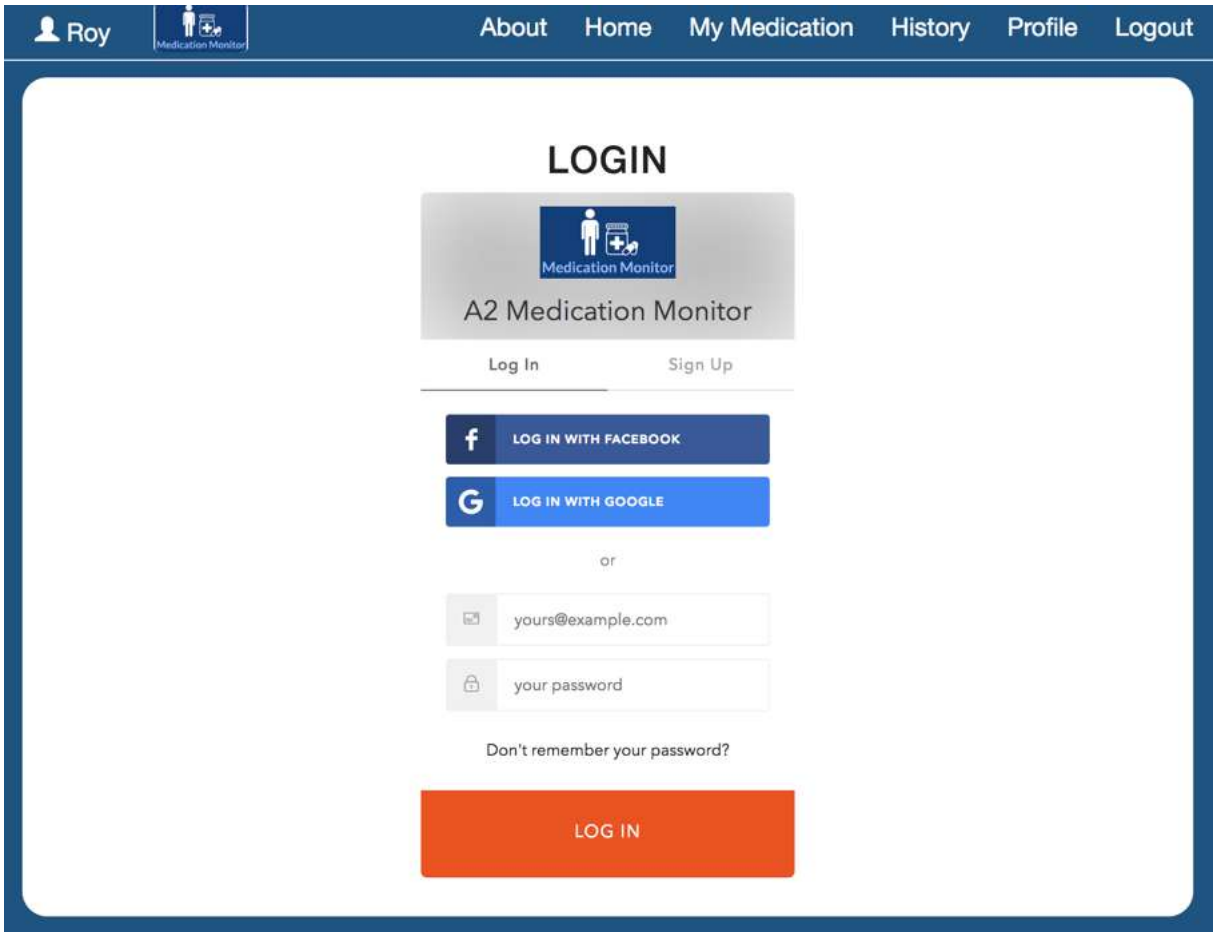
| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| X | | X | | |

1) If you did not notice the messages, what would be a better way to notify you?

A notification to the cellular phone

2) Do you have other suggestions for improving the notifications?

# Medication Monitor




1) How easy did you find log-in to the application?

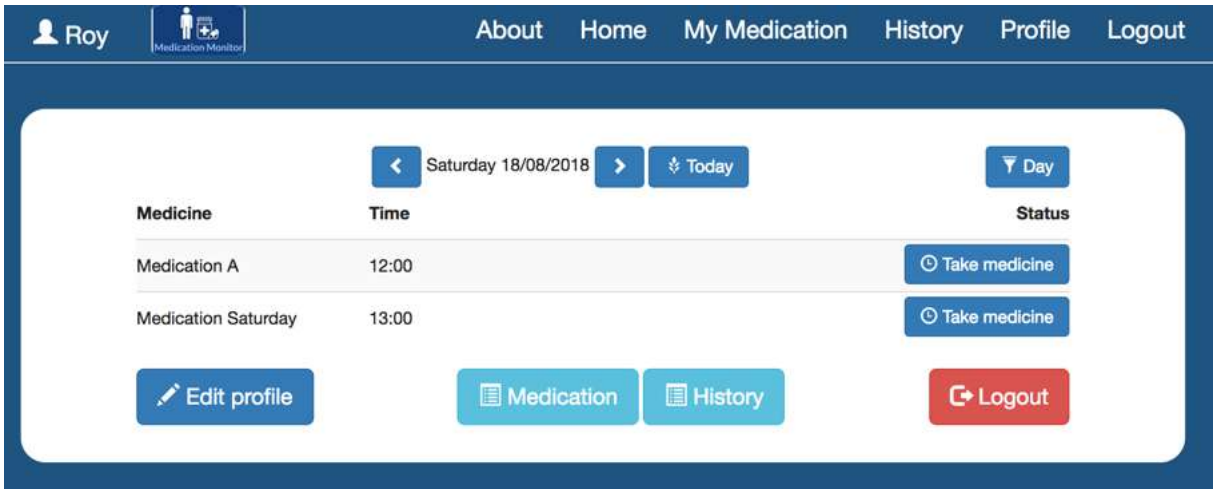
| **Very easy** **1** | **2** | **3** | **4** | **Very difficult** **5** |
|---|---|---|---|---|
| ○ xx | ○ | ○ | ○ | ○ |

1) Do you have any suggestions for improving the log-in?

Yes ☐ No ☒ xx

If Yes, please note ~~them~~ here:

| |
|---|
| |




2) How easy was it to get an overview of the medications you should take today?

| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| ○ X | ○ X | ○ | ○ | ○ |

1) Did you use the button to switch to a Week view (Day / Week)? NO/ Didn't use it. Didn't need it – and didn't look for it.

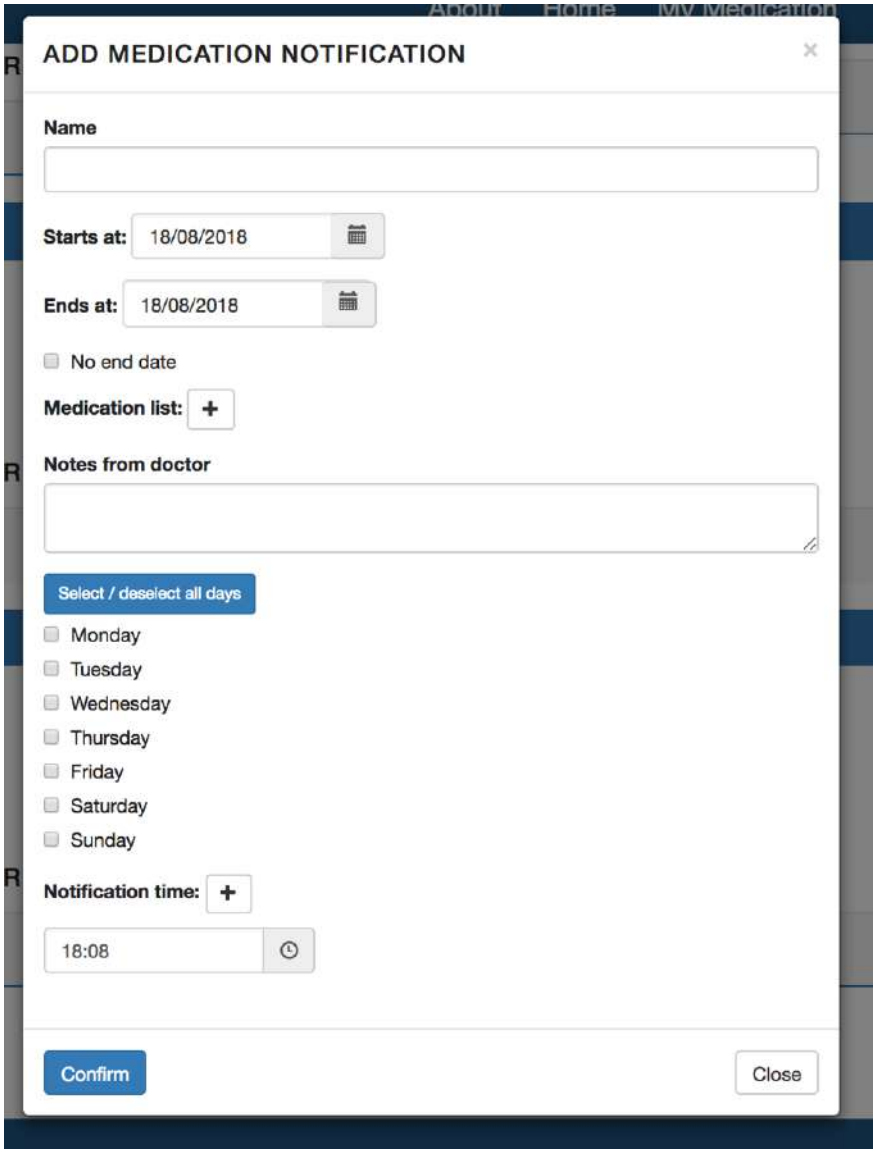
| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

1) Did you use the functionality to navigate back and forth in days?

Didn't always work

Didn't use it

| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| ○ X | ○ | ○ | ○ | ○ |



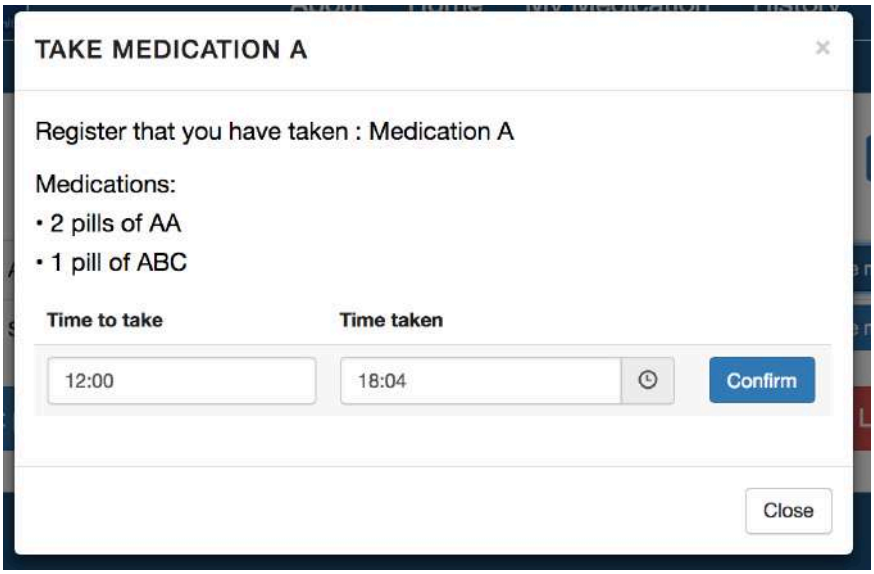

1) How easy was it to add a medication notification to your medication plan?

| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| X | X | | | |

1) Do you have suggestions to how we could improve the way for adding a medication notification to the medication plan?

Yes ☐ No XX

If Yes, please note them here:




2) How easy was it to register that you had taken your medication?

| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| ○ | ○ X | ○ X | ○ | ○ |

3) Do you have any suggestions for improving the way of registering that you have taken the medication?

Yes ☐ No XX

If Yes, please note them here:

4) In general, how useful did you find the Medication Monitor application?

| Not useful 1 | 2 | 3 | 4 | Very useful 5 |
|---|---|---|---|---|
| ○ | ○ | ○ X | ○ | ○ X |

1) Do you have suggestions to improvements that would make the Medication Monitor even better for you?

Yes [XX] No [ ]

If Yes, please note them here:

Have a «undo key» in case of mistake

If a medication is taken late (after 24.00) the registration ends on wrong date.

2) Would you continue to use the Medication Monitor application after the field trial if it was available to you?

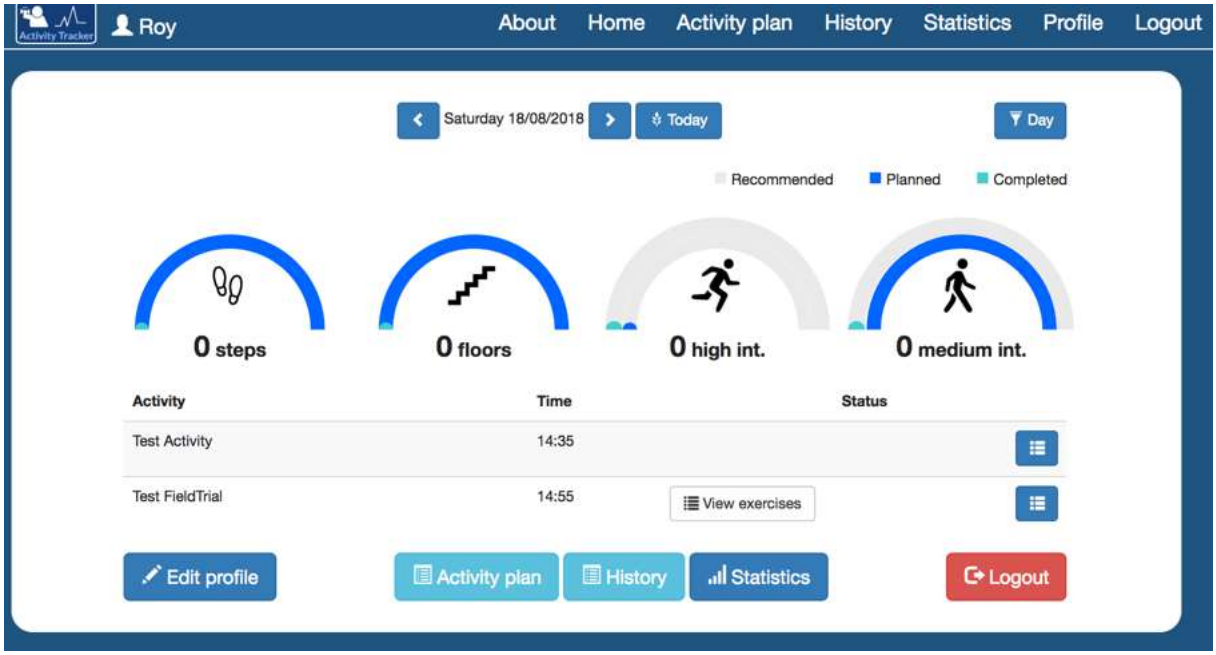
Yes [X] No [X]

3) Have you used or heard of a similar application earlier?

Yes [ ] No [XX]

If Yes, please note them here:

# Activity Tracker




4) How easy was it to understand the information in the home page?

| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| ○ XX | ○ | ○ | ○ | ○ |

1) What parts were hard to understand?

Yes ☐ No XX

If Yes, please note them here:

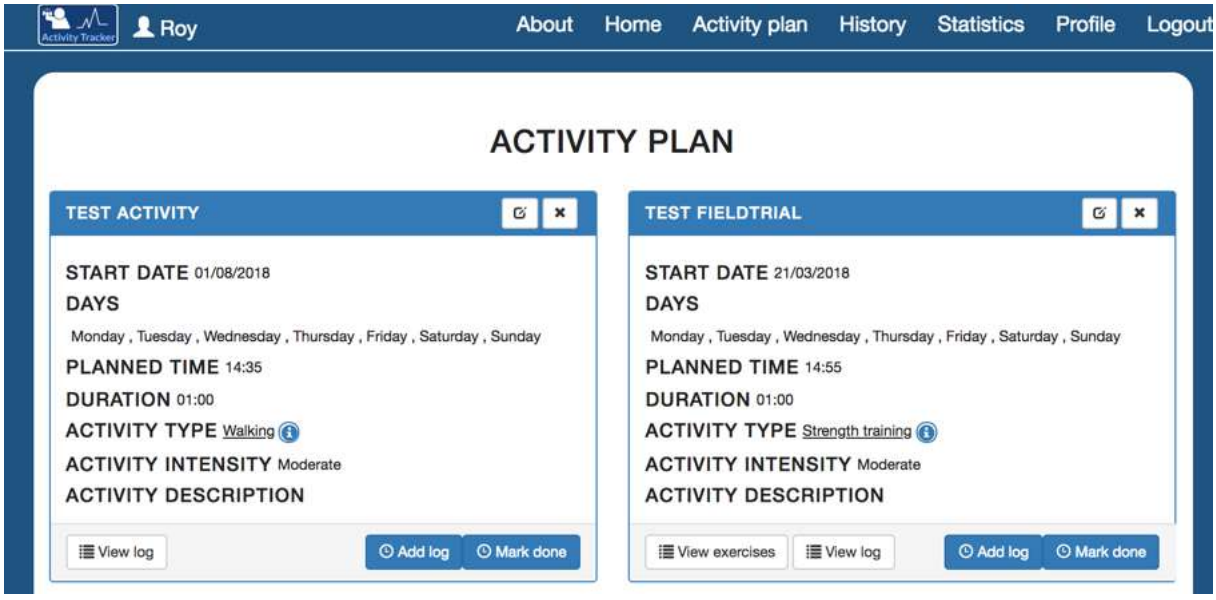
| |
|---|
| |

2) Do you have any suggestions for improving the home page?

Yes ☐ No XX

If Yes, please note them here:

| |
|---|
| |

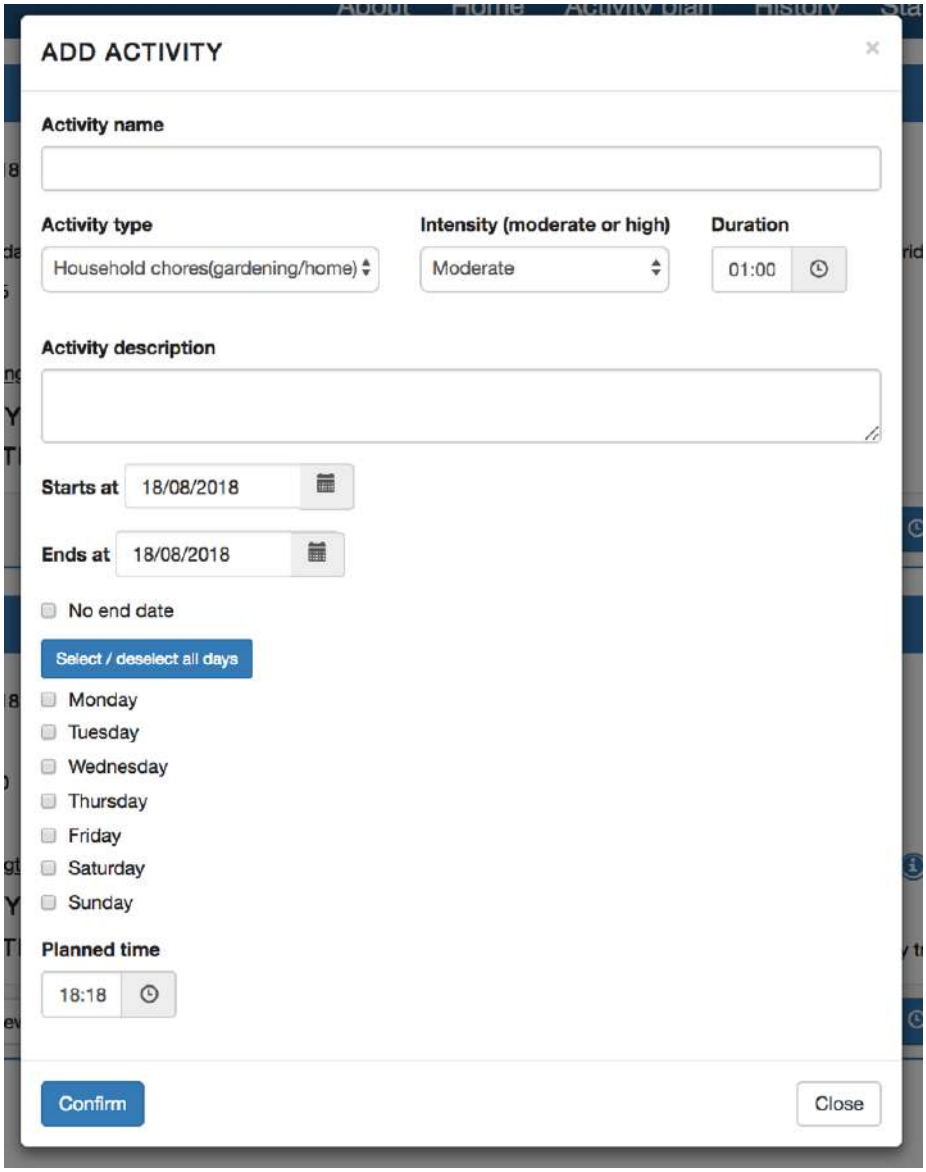



3) How easy did you find the Activity Plan page to use?

| **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|
| ○ X | ○ X | ○ | ○ | ○ |

1) How easy did find it to add an activity to your Activity Plan?

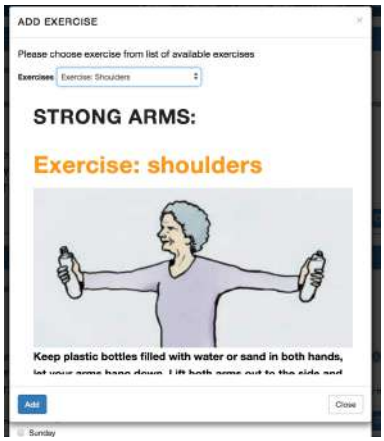
| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| ○ | ○ XX | ○ | ○ | ○ |




2) Did you try to create a "Strength Training" activity?

Yes [X] No [X]

If Yes, how easy did you find it to select and add exercises:




| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| ○ | ○ X | ○ | ○ | ○ |

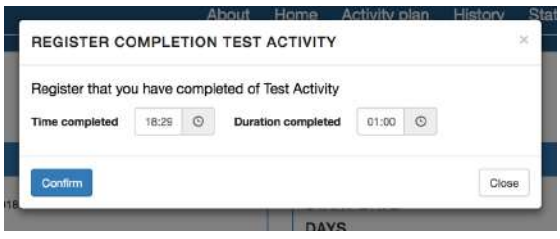
3) Do you have any suggestions for improving the way of adding activities?

Yes ☐ No XX

If Yes, please note them here:

| |
|---|
| |

4) How easy did you find it to mark an activity as completed?




| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| ○ X | ○ X | ○ | ○ | ○ |

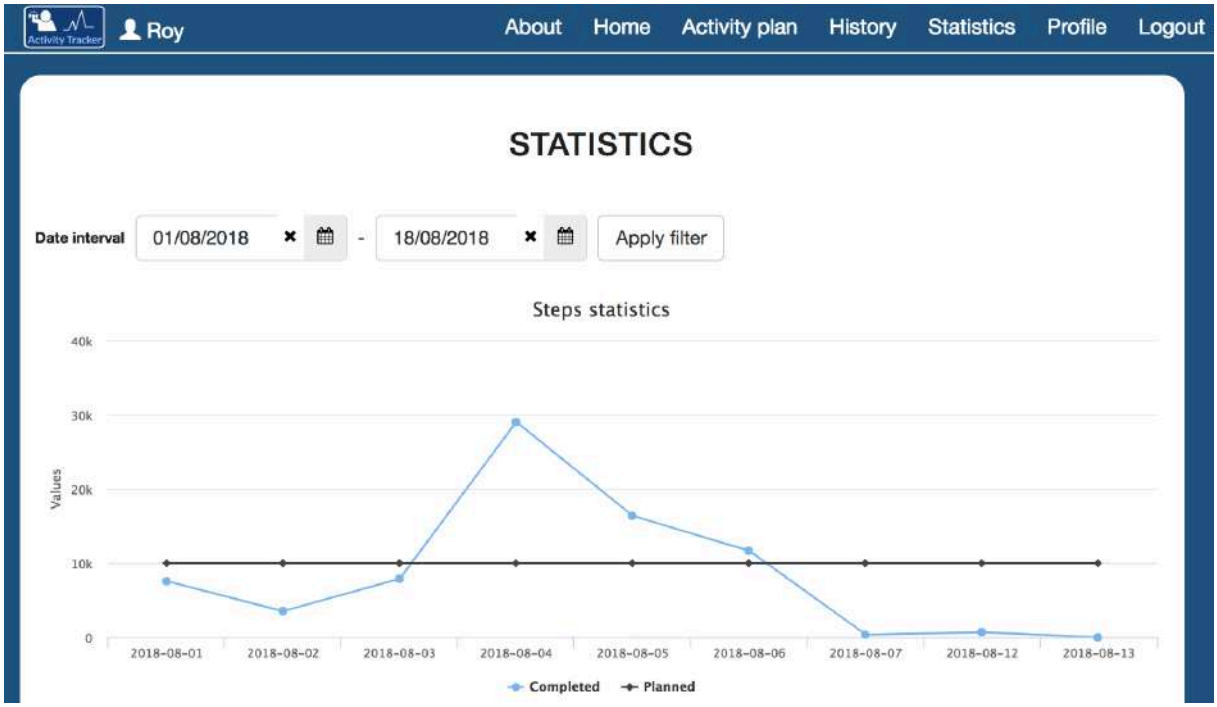
1) Do you have any suggestions for improving the way for recording that you completed an activity?

Yes ☐ No XX

If Yes, please note them here:

2) Did you use the "Statistics" page?

Yes ☐ No XX




If Yes, how easy did you find it to use this page, and was the information there understandable:

| **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|
| ○ | ○ X | ○ | ○ | ○ |

1) Was the information in the Statistic page valuble to you?

Yes ☐ No XX

2) Do you have any suggestions for improving the Statistic page?

Yes ☐ No XX

If Yes, please note them here:

| |
|---|
| |

3) In general, how useful did you find the Activity Tracker application?

| Not useful 1 | 2 | 3 | 4 | Very useful 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ XX | ○ |

4) Do you have suggestions to improvements that would make the Activity Tracker even better for you?

Yes X No X

If Yes, please note them here:

| |
|---|
| Not so flexible. One program for each training-day. I want that a weekly goal can be achieved by marking of and summing up the days you work out and then get an alert at the end of the week if you do not have enough training hours to achieve the goal. |

5) Would you continue to use the Activity Tracker application after the field trial if it was available to you?

Yes [X] No [X]

# Questionnaire

On the use and benefits of PersonAAL

# Remote Assistant Application

**SIGN-IN**


1) How easy did you find log-in to the application?

| **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|
| X | ○ | ○ | ○ | ○ |

2) How easy did you find select your language?

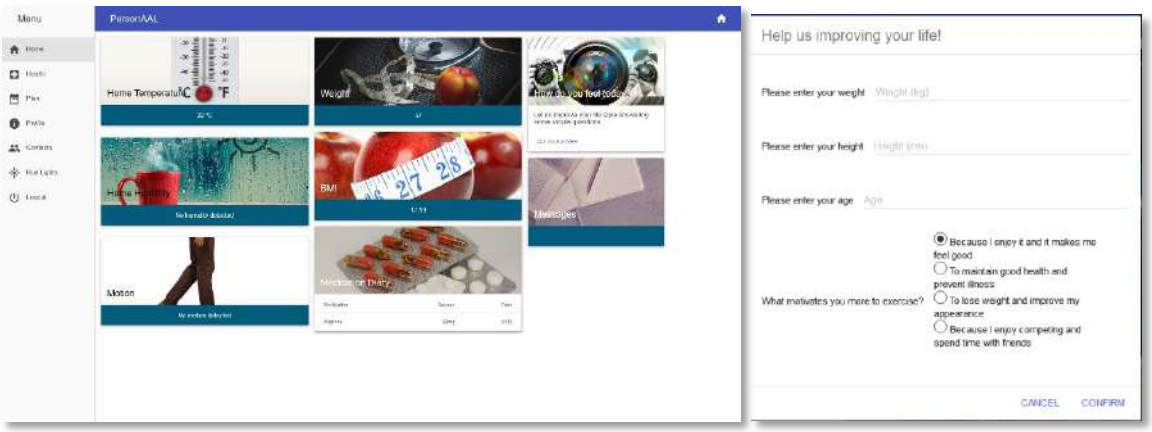
| **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|
| X | ○ | ○ | ○ | ○ |

3) Do you have any suggestions for improving the sign-in page?

Yes ☐ No ☑

If Yes, please note them here:

**HOME**




4) How easy did you find completing the survey?

| **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|
| X | ○ | ○ | ○ | ○ |

If You have comments on the survey, please note them here:

| |
|---|
| |

5) How useful did you find the information visualized in the Home page?

| | **Very useful 1** | **2** | **3** | **4** | **Very unuseful 5** |
|---|---|---|---|---|---|
| Home Temperature | X | ○ | ○ | ○ | ○ |
| Home Humidity | X | ○ | ○ | ○ | ○ |
| Motion | ○ | X | ○ | ○ | ○ |
| Weight | ○ | X | ○ | ○ | ○ |
| BMI | ○ | X | ○ | ○ | ○ |
| Medication Diary | X | ○ | ○ | ○ | ○ |

No comments.

If You have comments, please note them here:

| |
|---|
| |

6) Do you have any suggestions for additional environment sensors to include in the kit?

Yes ☐ No ☒

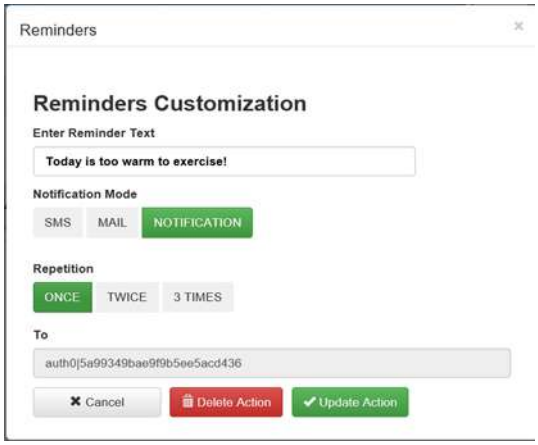
If Yes, please note them here:

| |
|---|
| |

7) Were you able to edit some rule to visualize a reminder message?

For example:

***IF*** *Temperature is (condition) more than 25 °C ,* ***DO*** *send reminder by notification to {myUserID}*




Yes ☒ No ☐

8) Did it work as expected?

Yes ☐ No ☒

If No, please explain (which rule did you try to edit? what you expected?):

| |
|---|
| It didn’t work, there was no action. |

9) Do you have any suggestions for improving the Home page?

Yes ☒ No ☐

If Yes, please note them here:

| |
|---|
| Make shure it really works before giving it out for tests. |

**HEALTH**


10) How easy did you find visualize the Respiration Rate and Heart Rate real time graphs?

| **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|
| X | ○ | ○ | ○ | ○ |

If You have comments, please note them here:

| |
|---|
| |

11) How useful did you find the information visualized in the Health page?

| | **Very useful 1** | **2** | **3** | **4** | **Very unuseful 5** |
|---|---|---|---|---|---|
| Hearth Rate | X | ○ | ○ | ○ | ○ |
| Respiration Rate | X | ○ | ○ | ○ | ○ |
| Internal Temperature | X | ○ | ○ | ○ | ○ |
| Position | X | ○ | ○ | ○ | ○ |

If You have comments on the information visualized, please note them here:

12) Do you have any suggestions for additional physiological sensors to include in the kit?

Yes [Y] No [ ]

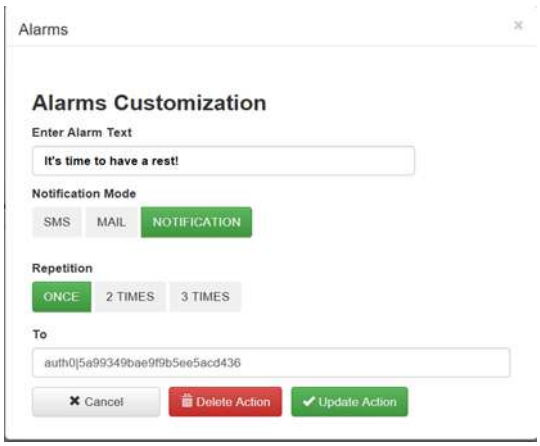
If Yes, please note them here:

Sedentary reminder, when you sit for a long period.

13) Were you able to edit some rule to visualize an alert message?

For example:

***IF*** *Heart Rate is (condition) more than 160 bpm* **, *DO*** *send a alarm by notification to {myUserID}*




Yes [Y] No [ ]

14) Did it work as expected?

Yes [ ] No [Y]

If No, please explain (which rule did you try to edit? what you expected?):

| |
|---|
| It did’nt work. |

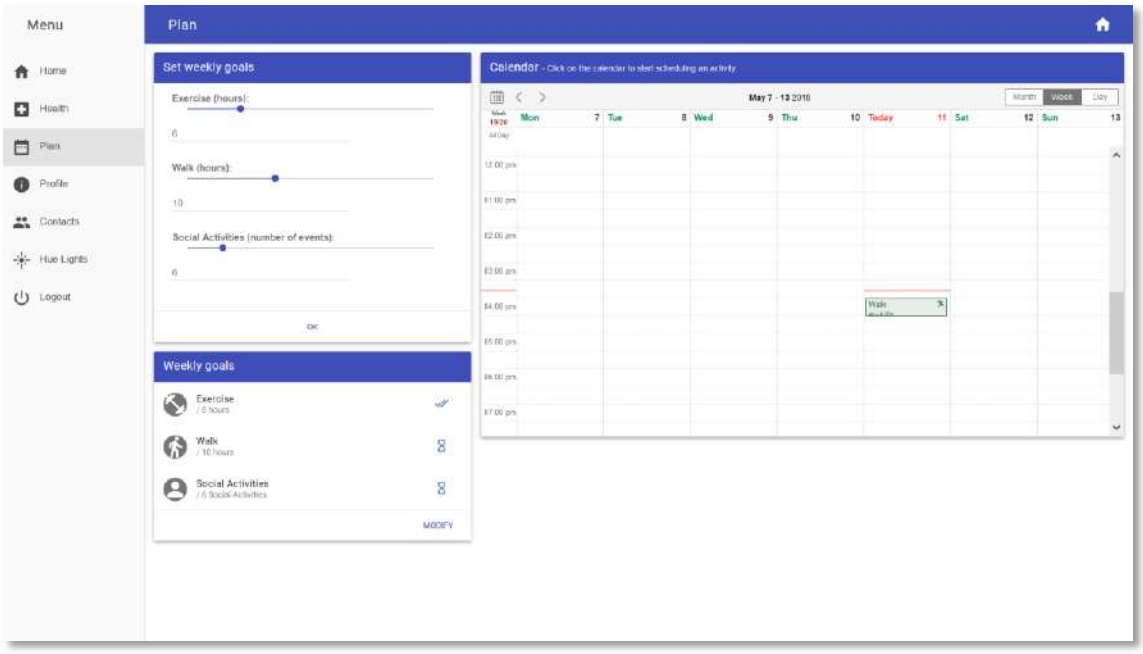
15) Do you have any suggestions for improving the Health page?

Yes [Y] No [ ]

If Yes, please note them here:

| |
|---|
| Same remark as above (9). |

**PLAN**




16) How easy did you find performing the following operations?

| | **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|---|
| Set and modify the weekly goals | X | ○ | ○ | ○ | ○ |
| Insert a new activity in the Plan | ○ | X | ○ | ○ | ○ |
| Delete or Edit an activity | X | ○ | ○ | ○ | ○ |
| Mark an activity as done | X | ○ | ○ | ○ | ○ |

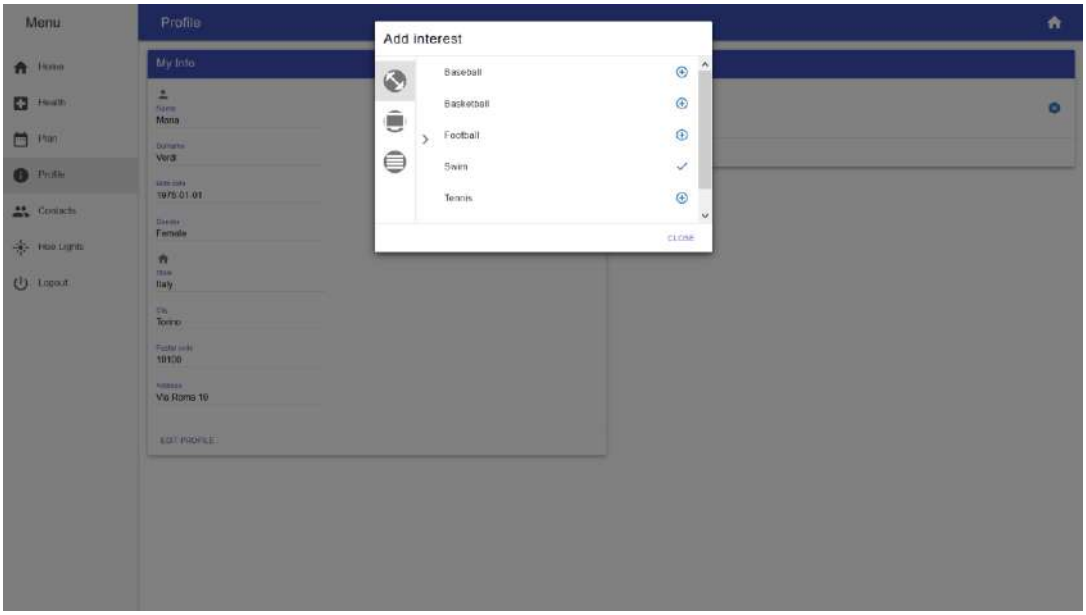
If You have comments, please note them here:

17) Do you have any suggestions for improving the Plan page?

Yes ☐ No ☒

If Yes, please note them here:

**PROFILE**




18) How easy did you find performing the following operations?

| | **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|---|
| Update Profile | ○ | X | ○ | ○ | ○ |
| Add Interests | ○ | X | ○ | ○ | ○ |

If You have comments, please note them here:

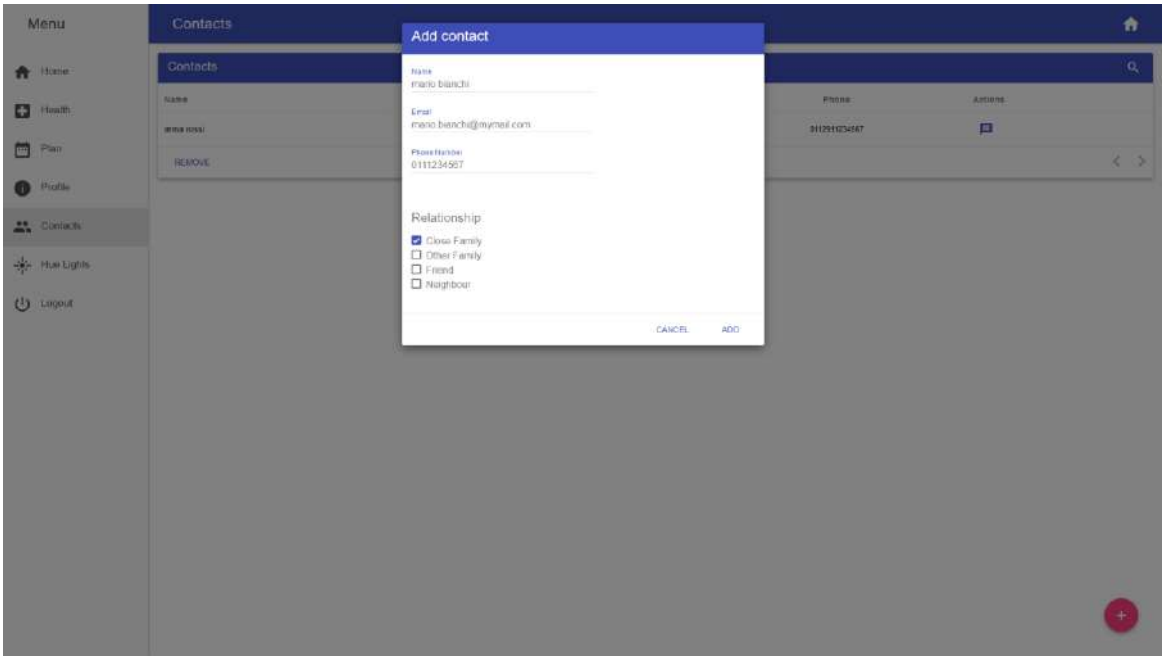
19) Do you have any suggestions for improving the Profile page?

Yes ☐ No ☒

If Yes, please note them here:

**CONTACTS**

20) How easy did you find performing the following operations?




| | **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|---|
| Add Contacts | X | ○ | ○ | ○ | ○ |
| Delete Contacts | X | ○ | ○ | ○ | ○ |

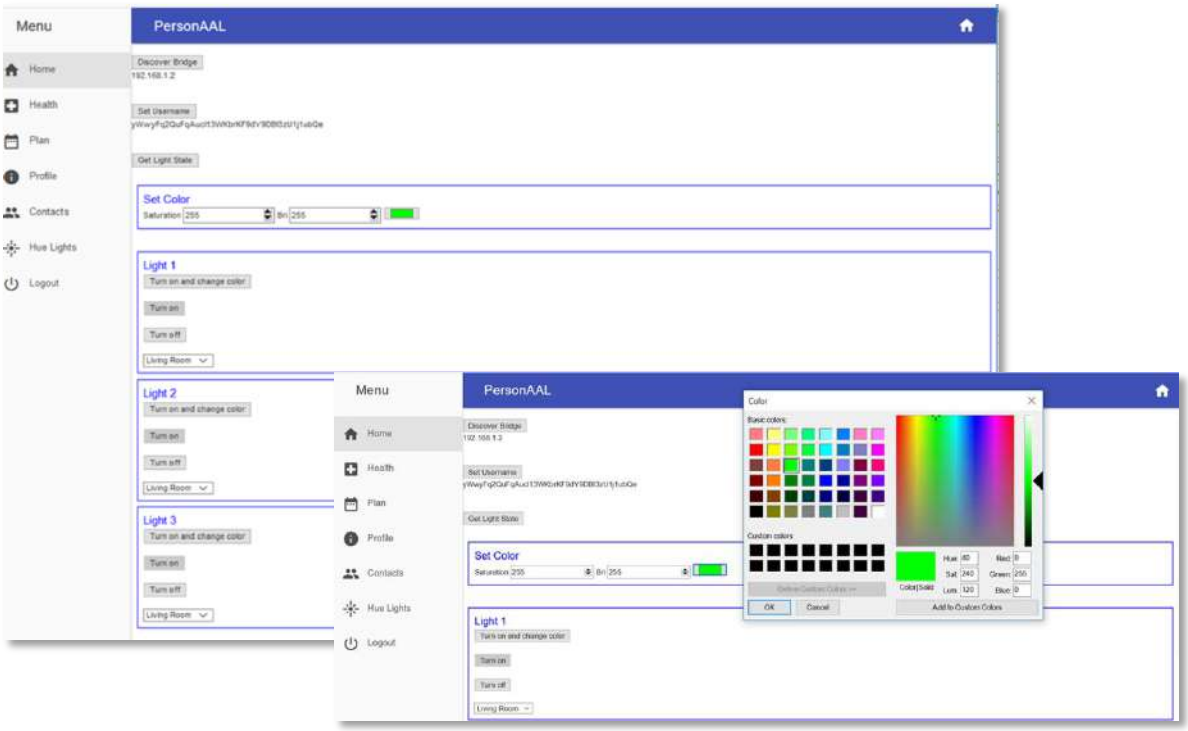
If You have comments, please note them here:

21) Do you have any suggestions for improving the Contacts page?

Yes ☐ No ☒

If Yes, please note them here:

**HUE LIGHTS**




22) How easy did you find performing the following operations?

(Please use Firefox with Security flag disabled)

| | **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|---|
| Discover Bridge | X | ○ | ○ | ○ | ○ |
| Set Username | X | ○ | ○ | ○ | ○ |
| Get Light State | X | ○ | ○ | ○ | ○ |
| Turn on/off/change color to lamp | ○ | X | ○ | ○ | ○ |

If You have comments, please note them here:

| |
|---|
| I do’nt see really the sense in HUE lamps, maybe ok for disco enthusiasts? |

23) Were you able to edit some rule to change the Hue Lights status?

For example:
*IF Time is after 22:00 **AND WHEN** Motion becomes true , **DO** Turn On and set color light Living Room color to White for 2 minutes*

Yes [Y] No [ ]

24) Did it work as expected?

Yes [ ] No [Y]

If No, please explain (which rule did you try to edit? what you expected?):

| |
|---|
| I tried twice or three times, but it never worked. |

25) Do you have any suggestions for improving the Hue Lights page?

Yes [Y] No [ ]

If Yes, please note them here:

| |
|---|
| Check functionality before giving them out for tests. |

26) Do you have any suggestions for additional appliances to control with rules?

Yes [ ] No [Y]

If Yes, please note them here:

| |
|---|
| |

**GENERAL**

27) Which of the functionalities available is most useful to you?

| |
|---|
| fitbit |

28) Which additional feature do you think it would be useful?

| |
|---|
| Maybe HUE |

29) If this application would be available at no cost, do you think you would use it?

Yes [Y] No [ ]

If you answered No could you please explain why?

| |
|---|
| |

# Persuasive Notifications

30) Did you find useful to receive persuasive notifications on your tablet?

Yes ☐ No ☒

Could you please describe some reasons why?

| |
|---|
| I have never received such messages |

31) Do you think receiving these notifications can increase your physical activity levels?

Yes ☒ No ☐

Could you please describe some reasons why?

| |
|---|
| Gets you mov/wing |

32) Do you think receiving these notifications can increase your social activity levels?

Yes ☒ No ☐

Could you please describe some reasons why?

| |
|---|
| Might be inviting to meet friends |

33) Was the frequency of the notifications appropriate?

Yes ☐ No ☑

If not, would you like to receive more or was it annoying?

| |
|---|
| Received none at all |

34) Was the content of the notifications appropriate?

Yes ☐ No ☐

If not, why?

| |
|---|
| |

# Chestband

## CHESTBAND

35) How easy was it to place the chestband on your chest?

| Very easy<br>1 | 2 | 3 | 4 | Very difficult<br>5 |
|---|---|---|---|---|
| ○ | X ○ | ○ | ○ | ○ |

36) Was the chestband comfortable to use?

| Very Comfortable<br>1 | 2 | 3 | 4 | Very discomfortable<br>5 |
|---|---|---|---|---|
| ○ | ○ | X ○ | ○ | ○ |

37) Did you experience any difficulties attaching the hub snaps to the band?

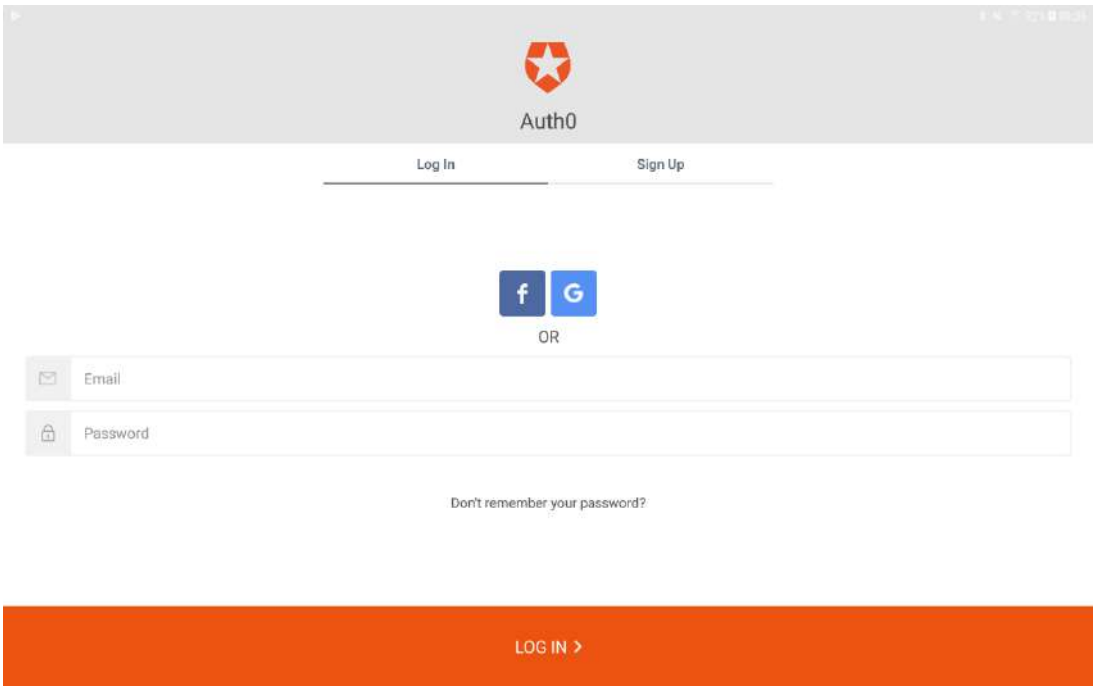
**Yes** ☐ **No** ☒ X

38) Do you have any suggestions for improving the chestband form factor?

**Yes** ☐ **No** ☒ X

| |
|---|
| |

If Yes, please note them here:




## CHESTBAND'S CONTEXT DELEGATE

### SIGN-IN

39) How easy did you find logging-in to the application?

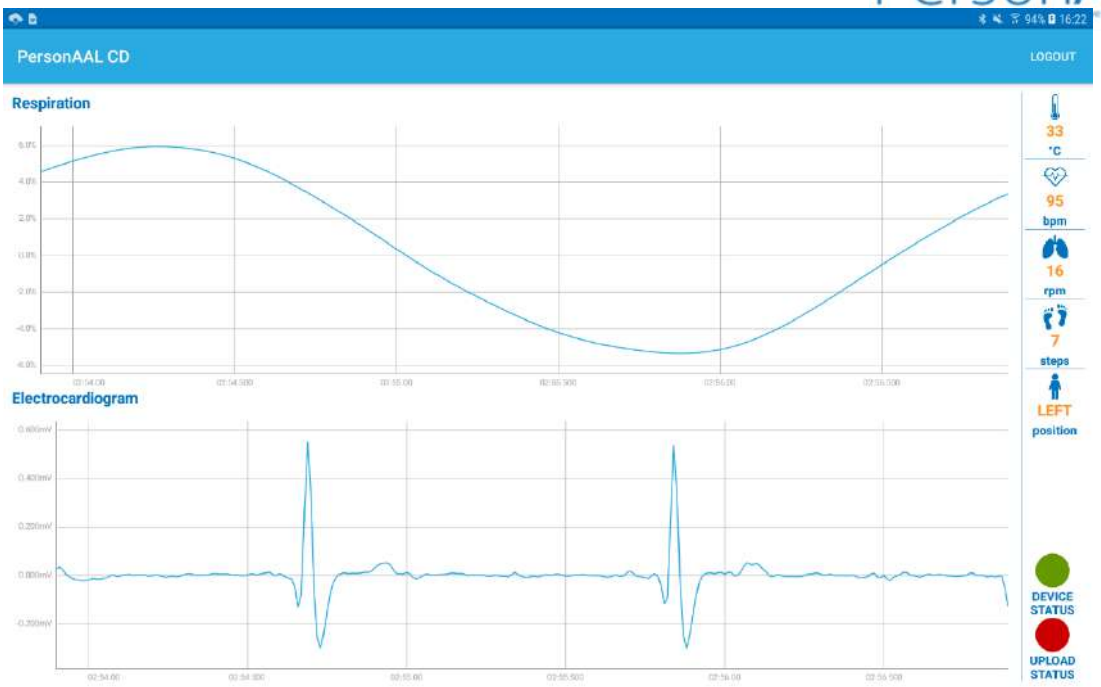
| Very easy<br>1 | 2 | 3 | 4 | Very difficult<br>5 |
|---|---|---|---|---|
| ○ | X ○ | ○ | ○ | ○ |

40) Do you have any suggestions for improving this view?

| |
|---|
| |

**Yes** [ ] **No** [X]

If Yes, please note them here:




**DATA DISPLAY**

41) How easy was it to understand the interface?

| Very easy<br>1 | 2 | 3 | 4 | Very difficult<br>5 |
|---|---|---|---|---|
| X | | | | |

42) How useful did you find the extracted values displayed on the right side of the screen?

| Very useful<br>1 | 2 | 3 | 4 | Very Unuseful<br>5 |
|---|---|---|---|---|
| X | | | | |

43) Were the values responsive, meaning, did they update properly?

| Always<br>1 | 2 | 3 | 4 | Never<br>5 |
|---|---|---|---|---|
| | | | X | |

44) How useful did you find the informative states (device and upload) displayed on the right bottom side of the screen?

| Very useful<br>1 | 2 | 3 | 4 | Unuseful<br>5 |
|---|---|---|---|---|
| | X | | | |

45) Did you use the context delegate as an aid to correctly place the chestband?

**Yes** ☐ **No** ☒

46) Do you have any suggestions for improving the Display Data view?

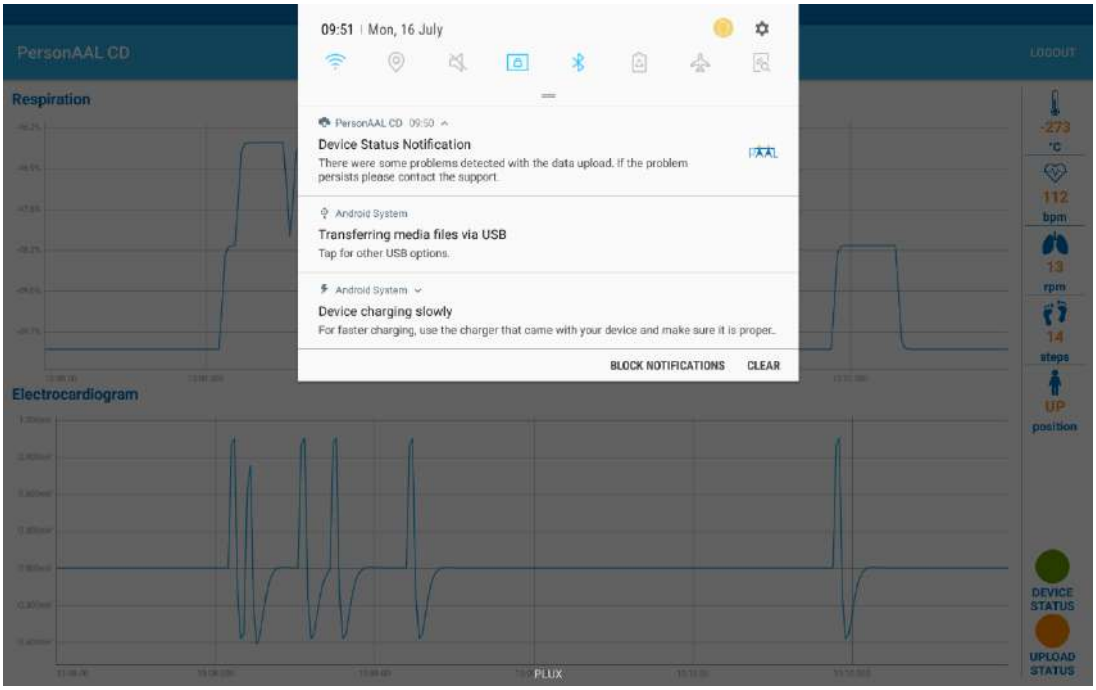
**Yes** ☐ **No** ☒

| |
|---|
| |

If Yes, please note them here:

**NOTIFICATIONS**

**Data Upload Notification**

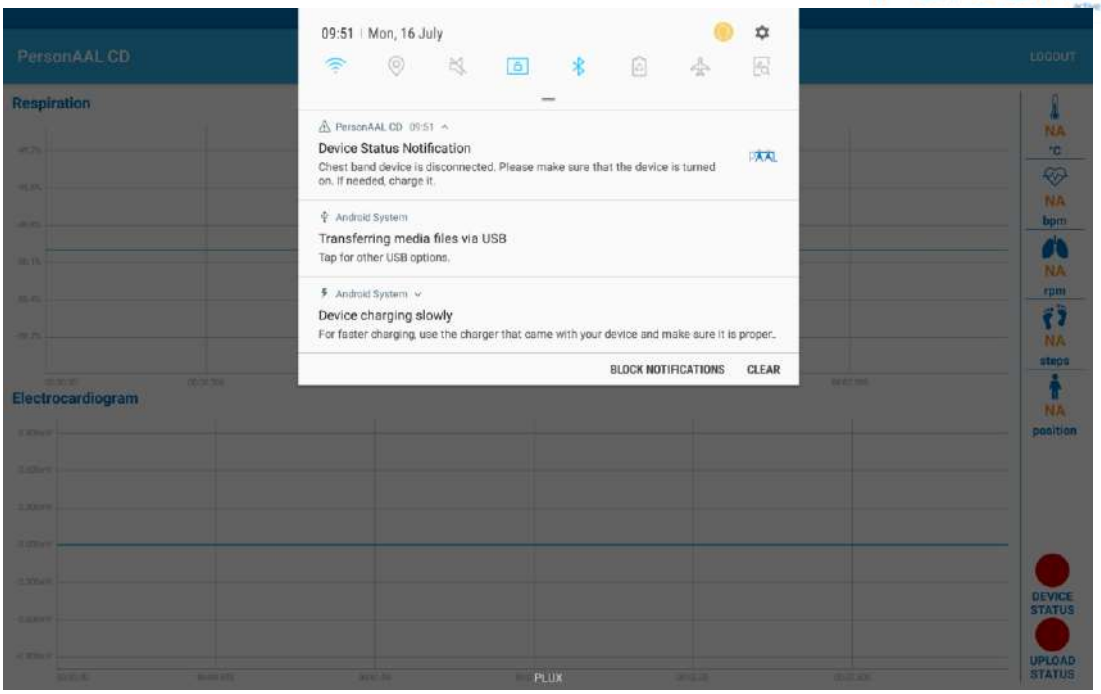



47) How often was this notification shown?

| Never | Once a day | Twice a day | More than 2 times a day | Always |
|---|---|---|---|---|
| ○ | X ○ | ○ | ○ | ○ |

48) Did you find this notification useful?

**Yes** ☒ **No** ☐




**Device Status Notification**

49) How often was this notification shown?

| Never | Once a day | Twice a day | More than 2 times a day | Always |
|---|---|---|---|---|
| ○ | X ○ | ○ | ○ | ○ |

50) Did you find this notification useful?

**Yes** [X] **No** [ ]

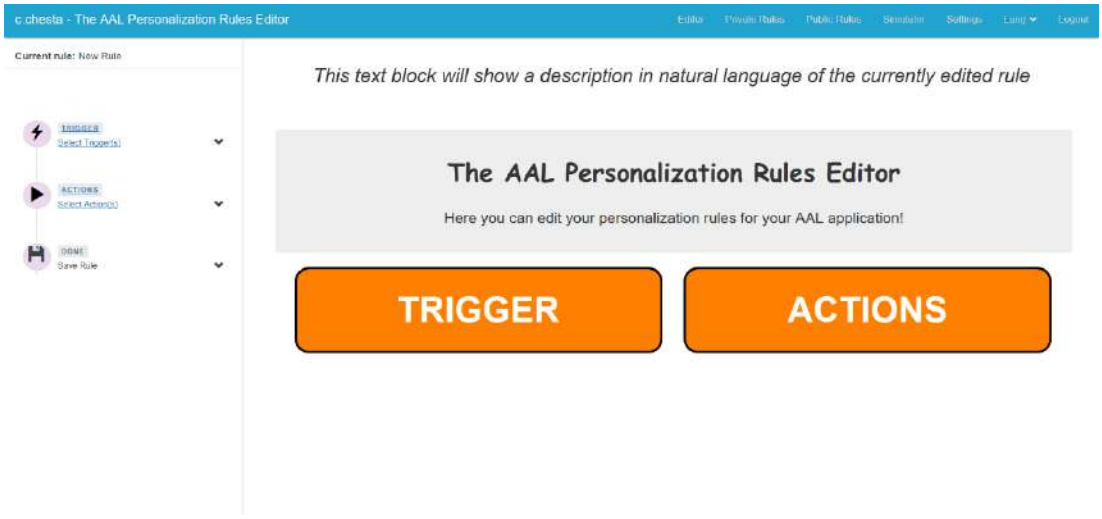
51) Do you have any suggestions of data or information that you would like to be notified of by the context delegate?

**Yes** [ ] **No** [X]

If Yes, please note them here:

| |
|---|
| The system was running ok for about 4 weeks. Afterwards I always received the message that CD had been stopped. I told Mr. Elhart about it and he informed Portugal, but there was no action taken! |

# Authoring Tool




**RULES EDITOR**

52) How often did you use the Rules Editor?

| Never | Once | Sometimes | Often | Every Day |
|---|---|---|---|---|
| ○ | ○ | X ○ | ○ | ○ |

53) How did you find it easy to use the editor?

| Very easy | Needed help only to start | Needed help sometimes | Needed help often | Very Difficult |
|---|---|---|---|---|
| ○ | ○ | X ○ | ○ | ○ |

54) Which functionalities of the rule editor did you find most useful?

| | Very useful 1 | 2 | 3 | 4 | Very unuseful 5 |
|---|---|---|---|---|---|
| Editor | ○ | X ○ | ○ | ○ | ○ |
| Private Rules | ○ | X ○ | ○ | ○ | ○ |
| Public Rules | ○ | X ○ | ○ | ○ | ○ |
| Simulator | ○ | X ○ | ○ | ○ | ○ |
| Side Map | ○ | X ○ | ○ | ○ | ○ |

55) Do you have any suggestions for additional functionalities?

**Yes** ☐ **No** ☒

If Yes, please note them here:

56) Have you added new rules with the rule editor?

**Yes** ☒ **No** ☐

If Yes, have you achieved the results you wanted with these new rules?

If No, did you try to define any additional rule, which did not succeed? Please explain.

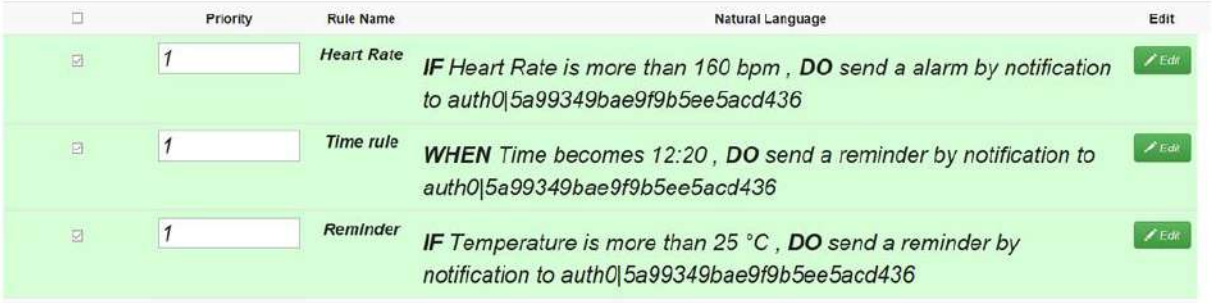
57) How do you rate the usability of the tool support for reusing previously saved rules?

| Very bad 1 | 2 | 3 | 4 | Very good 5 |
|---|---|---|---|---|
| ○ | X ○ | ○ | ○ | ○ |

58) How do you rate the usability of the tool support for saving and applying rules?

| Very bad 1 | 2 | 3 | 4 | Very good 5 |
|---|---|---|---|---|
| ○ | X ○ | ○ | ○ | ○ |

**RULES**



| | Priority | Rule Name | Natural Language | Edit |
|---|---|---|---|---|
| ☑ | 1 | Heart Rate | **IF** Heart Rate is more than 160 bpm , **DO** send a alarm by notification to auth0\|5a99349bae9f9b5ee5acd436 | Edit |
| ☑ | 1 | Time rule | **WHEN** Time becomes 12:20 , **DO** send a reminder by notification to auth0\|5a99349bae9f9b5ee5acd436 | Edit |
| ☑ | 1 | Reminder | **IF** Temperature is more than 25 °C , **DO** send a reminder by notification to auth0\|5a99349bae9f9b5ee5acd436 | Edit |

59) Did you find intuitive the rules description in natural language provided by the tool?

**Yes** [X] **No** [ ]

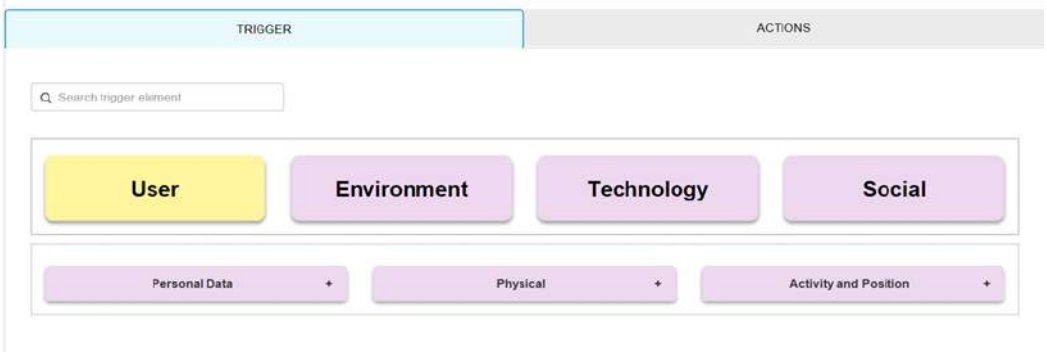
| |
|---|
| |

If No, please explain why:

60) How do you rate the usefulness of describing the rules in natural language?

| Very bad 1 | 2 | 3 | 4 | Very good 5 |
|---|---|---|---|---|
| ○ | X ○ | ○ | ○ | ○ |

61) How do you rate the usability of the trigger selection mechanism supported by the tool?




| Very bad 1 | 2 | 3 | 4 | Very good 5 |
|---|---|---|---|---|
| ○ | ○ | X ○ | ○ | ○ |

62) How do you rate the exhaustiveness of the set of events that can be specified with the tool?

| Very bad 1 | 2 | 3 | 4 | Very good 5 |
|---|---|---|---|---|
| ○ | ○ | X ○ | ○ | ○ |

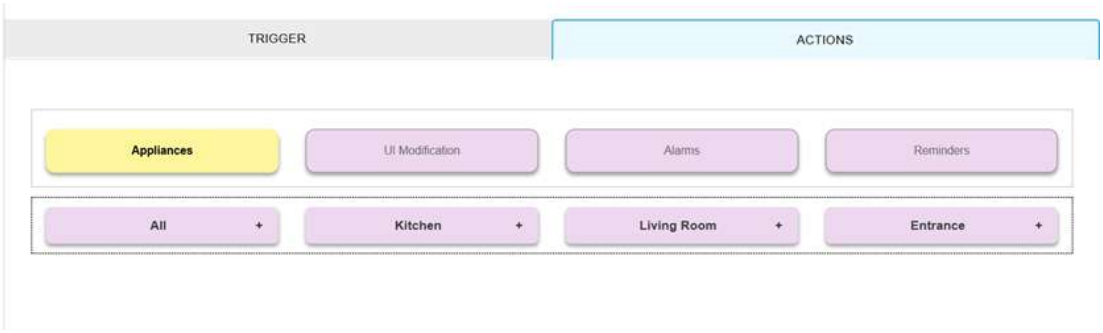
63) Do you have any suggestion to improve the hierarchy of events (e.g. elements to add/remove to/from the set of events)?

**Yes** ☐ **No** ☒

| |
|---|
| |

If Yes, please note them here:

64) How do you rate the usability of the action selection mechanism supported by the tool?




| Very bad 1 | 2 | 3 | 4 | Very good 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | X ○ | ○ |

65) How do you rate the exhaustiveness of the set of actions that can be specified with the tool?

| Very bad 1 | 2 | 3 | 4 | Very good 5 |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| ○ | ○ | X ○ | ○ | ○ |

66) Do you have any suggestion to improve the hierarchy of actions (e.g. elements to add/remove to/from the set of actions)?

**Yes** ☐ **No** ☒

| |
|---|
| It's all a bit too complicated for elderly people, not accustomed to pc's and internet |

If Yes, please note them here:

**GENERAL**

67) Do you think that this approach is useful to make context-dependent an application?

**Yes** ☐ **No** ☒

| |
|---|
| |

Please explain/motivate you answer:

68) Do you have any general suggestions to improve the Authoring Tool?

**Yes** ☐ **No** ☒

| |
|---|
| |

If Yes, please note them here:

# Notification App



1) How easy did you find it to log-in to the App?

| **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|
| X | | | | |

1) How intuitive was the Notification App to use?

| **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|
| X | | | | |

1) Did you find the Notification App hard to use?

Yes ☐ No ☑

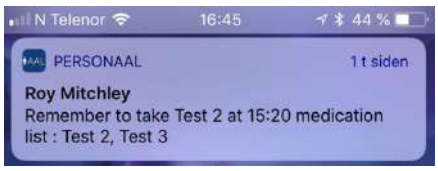
If Yes, please tell us what you found complicated and hard to understand:

2) Do you have any suggestions for improving the app?

Yes ☐ No ☒

If Yes, please note them here:

1) Did you notice the messages when they arrived?




| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| X | | | | |

1) Did you hear the sound message when the notification arrived?

| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| | | X | | |

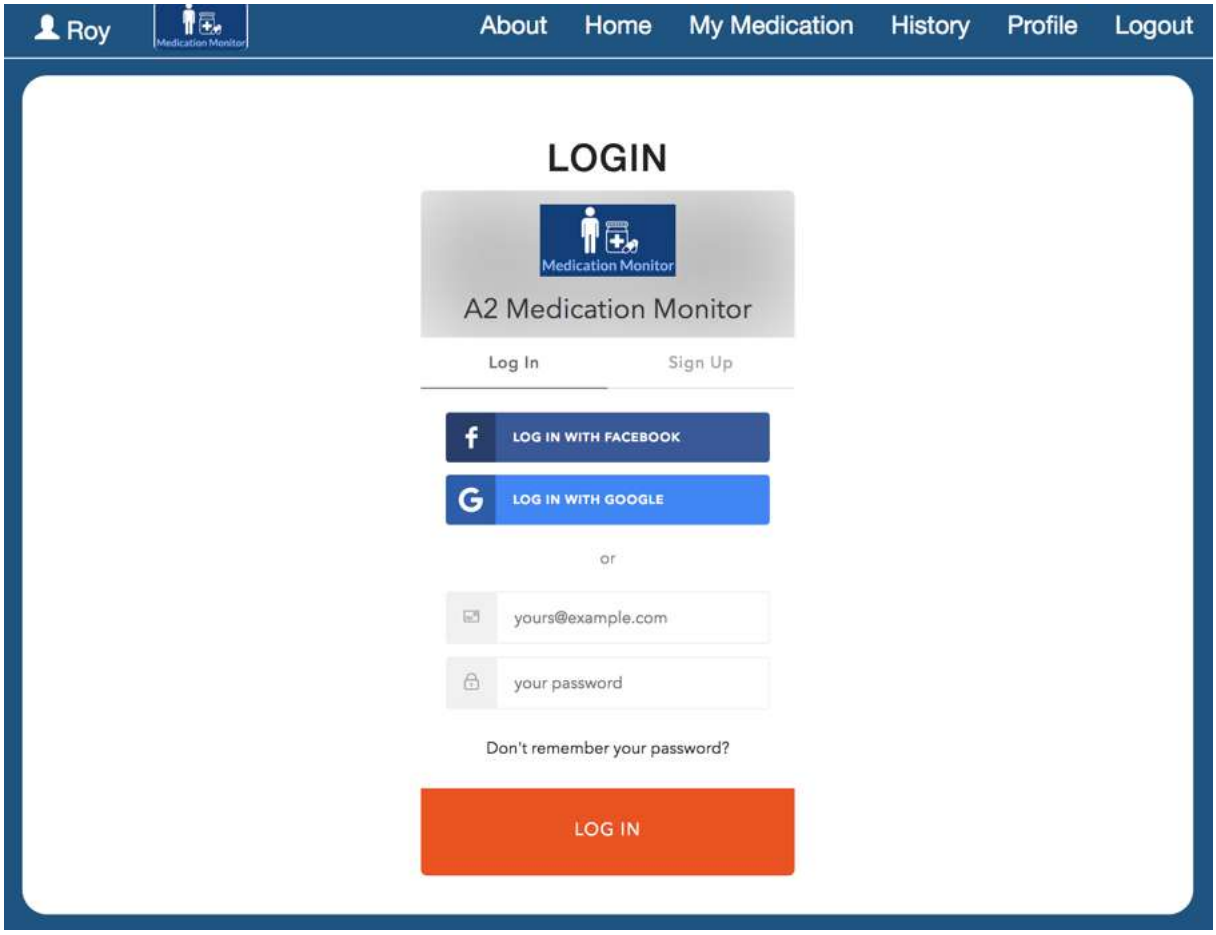
1) If you did not notice the messages, what would be a better way to notify you?

| |
|---|
| Louder or a different sound |

2) Do you have other suggestions for improving the notifications?

| |
|---|
| |

# Medication Monitor



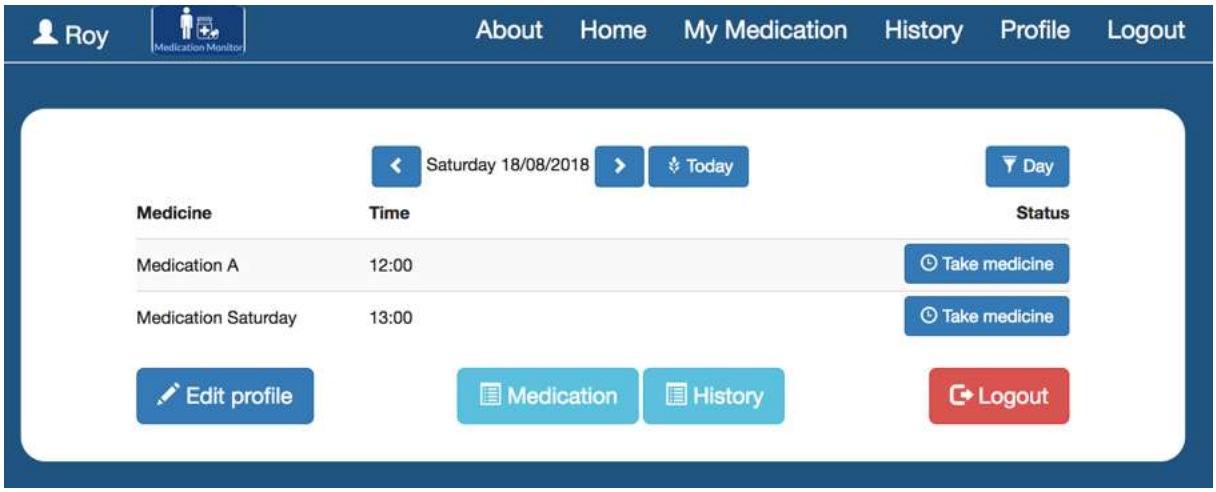

1) How easy did you find log-in to the application?

| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| X | | | | |

1) Do you have any suggestions for improving the log-in?

Yes ☐ No ☑

If Yes, please note them here:




2) How easy was it to get an overview of the medications you should take today?

| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| X | | | | |

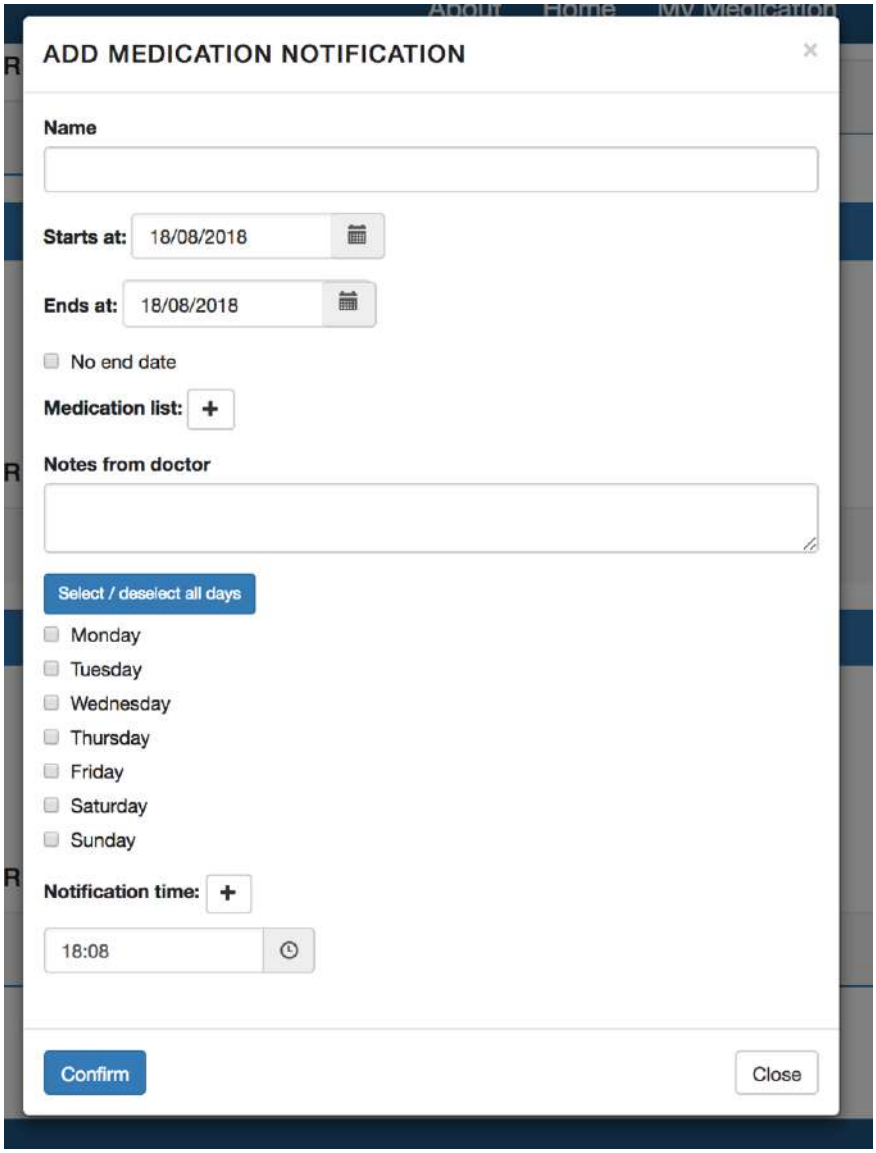
1) Did you use the button to switch to a Week view (Day / Week)?

| Very easy 1 | | | | Very difficult 5 |
|---|---|---|---|---|

| | 2 | 3 | 4 | |
|---|---|---|---|---|
| X | | | | |

1) Did you use the functionality to navigate back and forth in days?

| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| | | | X | |




1) How easy was it to add a medication notification to your medication plan?

| Very easy | | | | Very difficult |
|---|---|---|---|---|

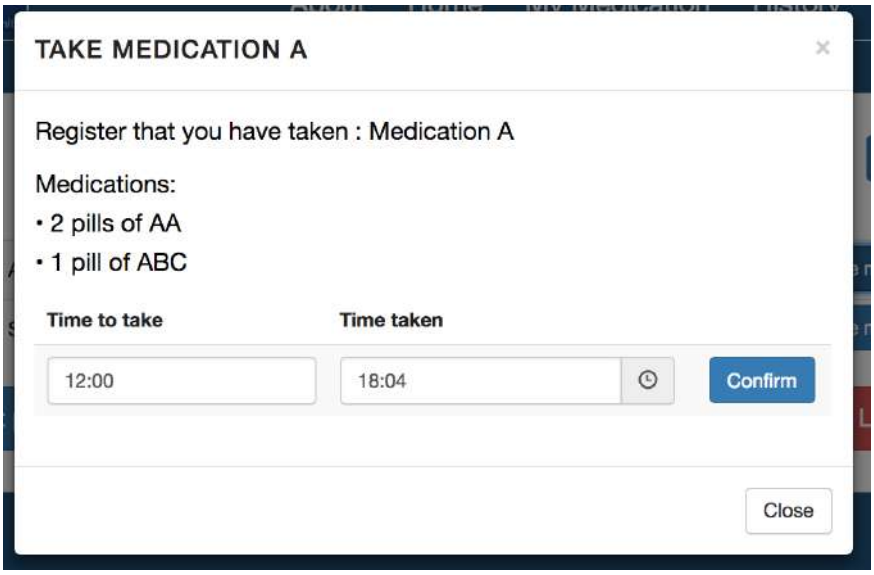
| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| X | | | | |

1) Do you have suggestions to how we could improve the way for adding a medication notification to the medication plan?

Yes ☐ No ☒

If Yes, please note them here:

| |
|---|
| |




2) How easy was it to register that you had taken your medication?

| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| X | | | | |

3) Do you have any suggestions for improving the way of registering that you have taken the medication?

Yes ☐ No ☒

If Yes, please note them here:

4) In general, how useful did you find the Medication Monitor application?

| Not useful 1 | 2 | 3 | 4 | Very useful 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | X ○ | ○ |

1) Do you have suggestions to improvements that would make the Medication Monitor even better for you?

Yes ☐ No ☒

If Yes, please note them here:

2) Would you continue to use the Medication Monitor application after the field trial if it was available to you?

Yes ☒ No ☐

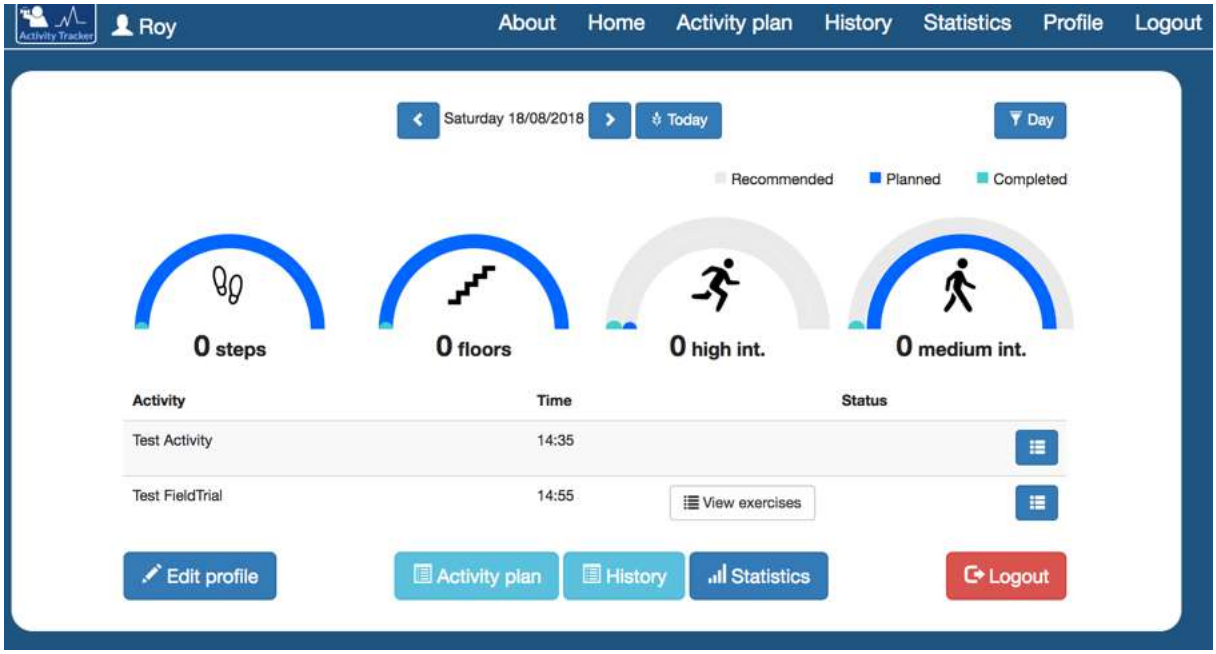
3) Have you used or heard of a similar application earlier?

Yes ☐ No ☒

If Yes, please note them here:

| |
|---|
| |

# Activity Tracker




4) How easy was it to understand the information in the home page?

| **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|
| X ○ | ○ | ○ | ○ | ○ |

1) What parts were hard to understand?

Yes ☐ No ☒

If Yes, please note them here:

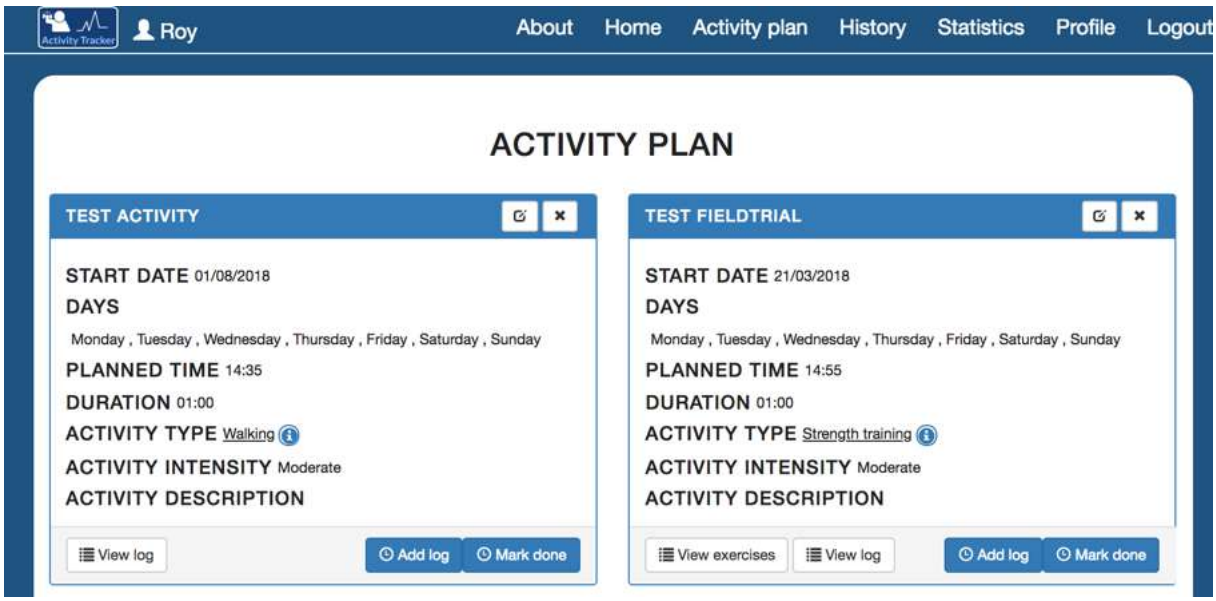
| |
|---|
| |

2) Do you have any suggestions for improving the home page?

Yes ☐ No ☒

If Yes, please note them here:

| |
|---|
| |



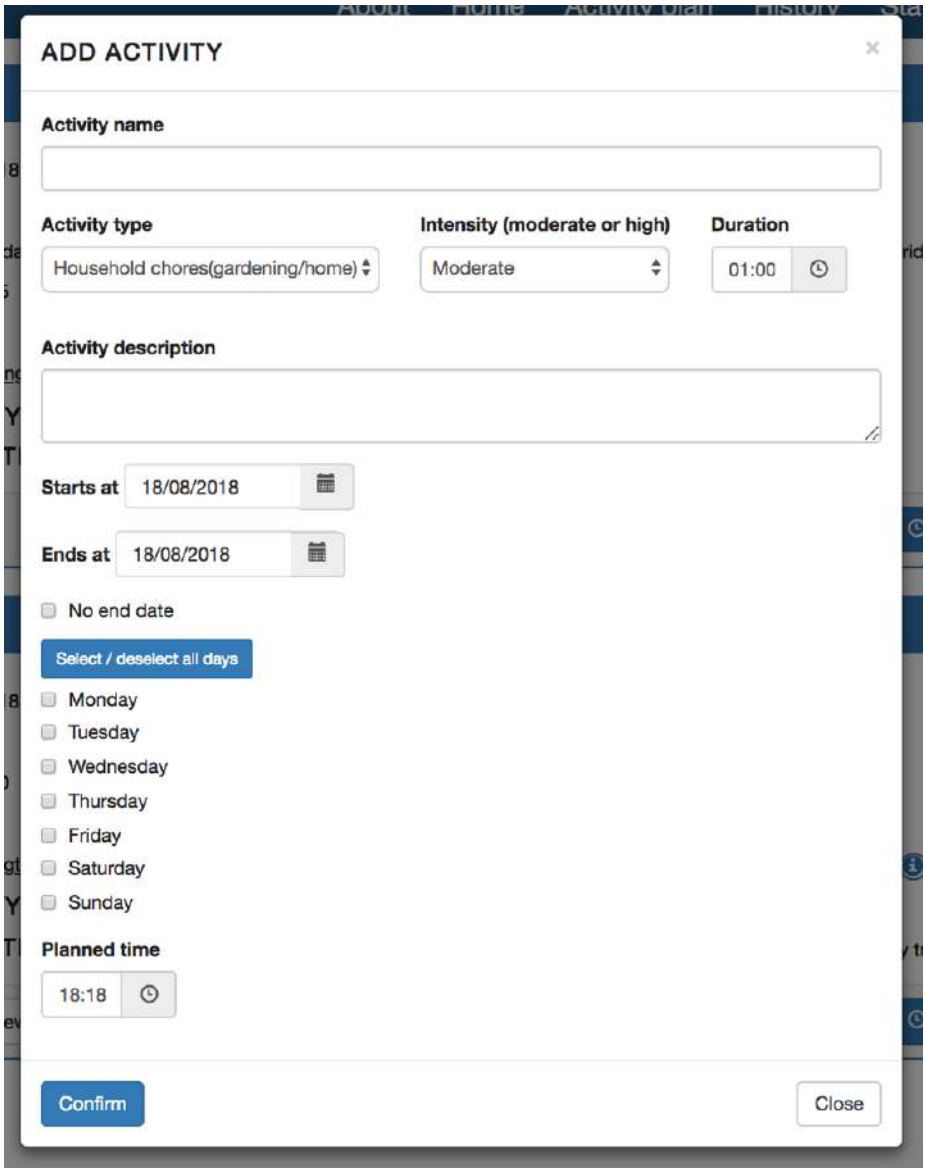

3) How easy did you find the Activity Plan page to use?

| | | | | |
|---|---|---|---|---|
| **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |

| | | | | |
|---|---|---|---|---|
| ○ | X ○ | ○ | ○ | ○ |

1) How easy did find it to add an activity to your Activity Plan?

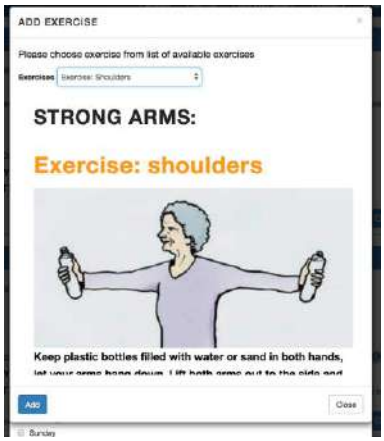
| **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|
| ○ | X ○ | ○ | ○ | ○ |




2) Did you try to create a "Strength Training" activity?

Yes ☐ No ☑

If Yes, how easy did you find it to select and add exercises:




| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

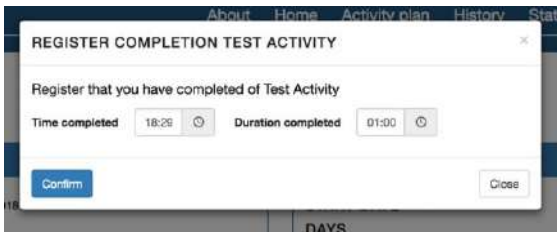
3) Do you have any suggestions for improving the way of adding activities?

Yes ☐ No ☑

If Yes, please note them here:

| |
|---|
| |

4) How easy did you find it to mark an activity as completed?




| Very easy 1 | 2 | 3 | 4 | Very difficult 5 |
|---|---|---|---|---|
| ○ | X ○ | ○ | ○ | ○ |

1) Do you have any suggestions for improving the way for recording that you completed an activity?

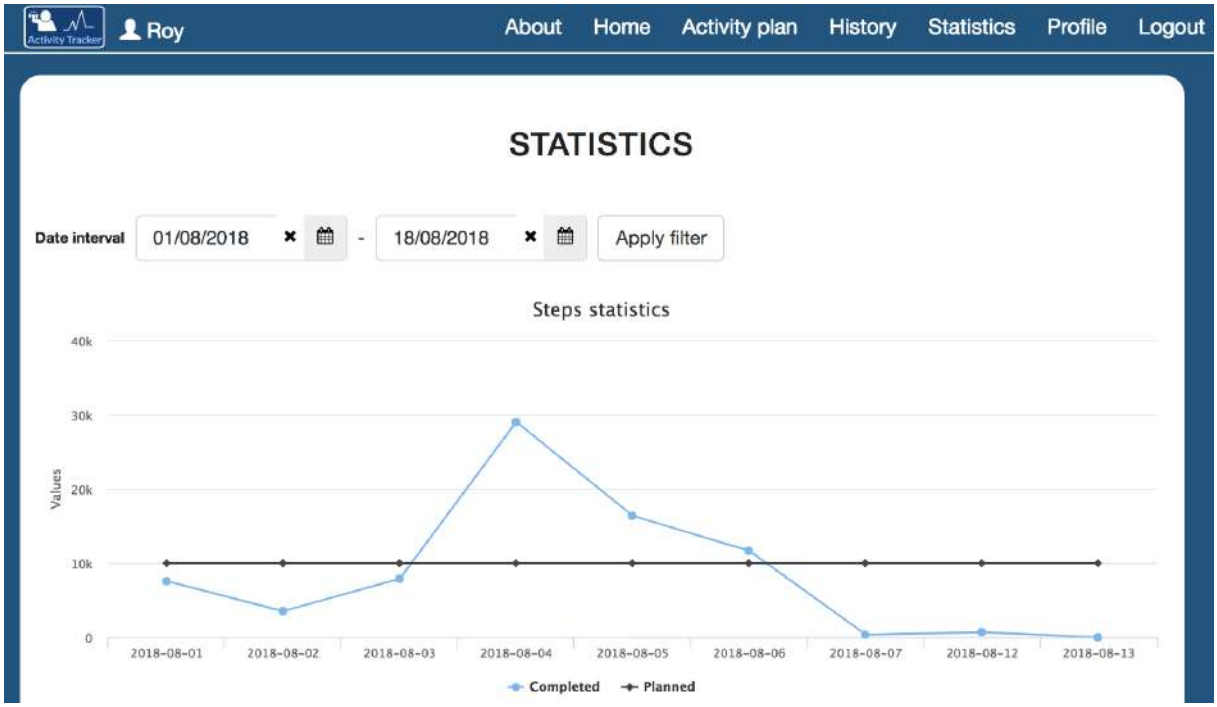
Yes ☐ No ☒

If Yes, please note them here:

| |
|---|
| |

2) Did you use the "Statistics" page?

Yes ☐ No ☒




If Yes, how easy did you find it to use this page, and was the information there understandable:

| **Very easy 1** | **2** | **3** | **4** | **Very difficult 5** |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

1) Was the information in the Statistic page valuble to you?

Yes ☐ No ☐

2) Do you have any suggestions for improving the Statistic page?

Yes ☐ No ☐

If Yes, please note them here:

| |
|---|
| |

3) In general, how useful did you find the Activity Tracker application?

| **Not useful 1** | **2** | **3** | **4** | **Very useful 5** |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | X ○ |

4) Do you have suggestions to improvements that would make the Activity Tracker even better for you?

Yes ☐ No ☑

If Yes, please note them here:

| |
|---|
| |

5) Would you continue to use the Activity Tracker application after the field trial if it was available to you?

Yes [Y] No [ ]