Designing an accessible alternative to dating apps for disabled people

Ruben Baggen, 6600107
Utrecht University
Utrecht, The Netherlands
r.s.j.baggen@students.uu.nl

Jonathan Baumann, 6589863
Utrecht University
Utrecht, The Netherlands
j.baumann@students.uu.nl

Lisa Hordijk, 5885043
Utrecht University
Utrecht, The Netherlands
j.e.hordijk@students.uu.nl

Joppe Kooistra, 6129951
Utrecht University
Utrecht, The Netherlands
j.kooistra1@students.uu.nl

Samuel Spithorst, 5956684
Utrecht University
Utrecht, The Netherlands
s.f.spithorst@students.uu.nl

ABSTRACT

People with a disability often face greater challenges in dating and finding a partner than those without disabilities. Our goal is to create a dating app that is accessible for people with disabilities. By doing so, we aim to reduce the loneliness and isolation often experienced by this group. We propose an interface in accordance with the AccessGuide and W3C guidelines, based on the needs of four groups of impairments, namely visual, physical, neurological/cognitive and auditory. Recommendation systems are crucial for online dating services, as they help users narrow down their choices and find quality matches. Therefore, we propose our own adaptation of the RECON algorithm with negative preferences, a reciprocal content-based filtering approach for providing match recommendations to the users optimised to avoid rejection. A multi-method evaluation is devised to measure the accessibility of the application. The app would be evaluated using a mock-up with a focus group, where participants are monitored during the completion of disability-specific navigational tasks. The feedback from the focus group will be used to alter the app so that it is more user friendly. The speed and efficiency measurements will also be used to improve the app. We propose to use a questionnaire with closed questions to evaluate the usability and user satisfaction of the app.

KEYWORDS

Disability, dating, accessibility, recommender algorithm

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1 INTRODUCTION

In the general population, loneliness has been associated with a negative impact on both mental and physical health, and quality of life [7]. These problems are only further exacerbated for people with disabilities, who according to multiple studies experience loneliness significantly more than their non-disabled counterparts [18] [11]. According to MacDonald et al. [11], this is partly caused by a lack of romantic relationships among members of this group. Popular dating apps like Tinder and Bumble are not fully accessible for these people [14]. This introduces barriers when people with disabilities want to use a dating app. A solution to this would be accessible technology, which can be used by people with disabilities in the same way as everyone else because it does not rely on having specific senses or abilities. Above that, accessible technology is more usable for the general population because it increases the general usability of the software [8].

Dating apps aimed at disabled people do exist but do not adapt to the specific handicap at hand. Furthermore, by only targeting the disabled part of the population, they reduce the dating pool for these people. This is where our solution comes in. We aim to research how a general dating app can be made accessible for people with disabilities. The interface will be created as accessible by design. Through this, we hope to cater to a broad spectrum of disabilities, as well as being available to others. In doing so, we hope to combat the loneliness and isolation issues people with disabilities face.

2 RELATED WORK

People with a disability often experience greater challenges with dating and finding a partner than people without disabilities [12]. Online dating offers a way to escape disability stigma and the limited dating pools [13]. Especially in developed countries, numerous romantic relationships and other advantages come from using online dating services for people with a disability. Online dating provides a broad range of potential partners, and a convenient, private way of meeting them. Users can choose how they present both themselves and their disabilities and how they communicate with potential partners. They can also decide whether they join a large, popular dating site or a more specialized one for people with a disability. [12].

Technologies that are inherently designed to be inclusive for all users, regardless of ability, are known as accessible technologies. To be accessible, the technology should be usable in an equal manner for all users, without relying on specific senses or abilities. It should also be compatible with assistive technologies its users may rely on, such as narrators, speech recognition, alternate input, enlargement, voice-activated technologies, refreshable Braille, and many other devices disabled people may use [8]. Several guidelines have been created to assist in the development of more accessible online subject matter. The World Wide Web Consortium (W3C)

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established a foundation for this, called the Web Content Accessibility Guidelines (WCAG). They state that subject matter should be perceivable, operable, understandable, and robust for all users [4]. These guidelines will be further detailed in section 5.

In addition to accessible technologies, recommender systems are also crucial for an online dating service. They help the user combat information and choice overload when looking for a potential match. They can narrow down a selection further than simple filters (such as age, gender or location) can, and provide quality suggestions that lead to fewer rejections [2]. When designing a recommender system for online dating, it is important to note that they are substantially different than common other recommender systems. One of the most important characteristics is that of reciprocity. Traditionally, a recommender system is designed to recommend a (series of) item(s) to the active user and therefore to make a recommendation it needs to account solely for the preferences of that single user. In online dating however, the active user is looking to find another user to connect with. This other (match-candidate) user has to then also mutually like the active user to form a match. Whereas traditionally, only the subject user has to assess whether or not the recommended object is a good fit, here the subject and object form a reciprocal relationship, meaning they both have to assess each other [15]. Our choice for an algorithm that takes this into account will be elaborated on in section 4.

3 USER MODEL

To start implementing an adaptive solution for an accessible dating app, information regarding different actors and impairments has been extracted from literature [4]. Expert evaluation of the proposed Web Content Accessibility Guidelines 2.0 (WCAG) prescribes four modalities of impairment: visual, physical, auditory and cognitive/neurological [5]. These four are the basis of the accessibility user-model as can be seen in Figure 1.

Each category is subdivided in different aspects, itemized with numbers that will be used to classify different needs for the specific user and highlighted in the following summation:

- **Visual:** To specify the needs of a visual impaired person three key distinctions are made: is the person blind (A1), colour-blind (A2) or otherwise visually impaired (A3).
- **Physical:** physical impaired people do not necessarily have a hard time navigating an app. However, for the people that are not able to do this, a distinction is made between the preference of using voice command (A4) or their own adapted input device (A5).
- **Cognitive, neurological:** To best accommodate the wide range of cognitive and neurological impairments, the app as a whole can best be adapted with good practices. To make reading and understanding text easier A6 is added as an option.
- **Auditory:** People with auditory impairment have no problems navigating a visual application. On the off chance a message is conveyed through audio, users have to specify if they want that message transcribed (A7). Or the information of the sounds is graphically made clear.

The categories and aspects of the user-model for the recommender system algorithm are elaborated on in the next section.

For each aspect explicit and implicit information denoted as (e) and (i) respectively, is accumulated either by direct information input, system information imported from the phone or user interactions with the app.

4 RECOMMENDER ALGORITHM

4.1 Algorithm Selection

While the goal of our research is to design a dating app, the focus is lies on usability and accessibility and not on creating the optimal recommender algorithm for user-to-user suggestions. In the following section we do propose an algorithm for providing match candidate recommendations to users, but it is outside of the scope of this paper to fully research, evaluate and optimise it.

It is important to note that despite our dating application being targeted at people with disabilities, the implementation does not use or require information about a user's disability to generate a list of recommendations. As a result the system can not differentiate between the various disabilities of users and therefore prevents discrimination based on user ability at an algorithmic level.

A clear overview of (research into) some other existing algorithms in the field of online dating was conducted by [2]. The key ones being: RECON [16] [17], CCR [1] and using multiple compatible subgroups [9]. They also propose a new method using Thompson sampling [2]. Out of these algorithms, the RECON algorithm [16], a content-based recommender system with the implementation of negative preferences [17], was selected and adapted for use in our dating app. There are three main reasons for this. Most importantly: it is one of the only algorithms that, due to it not discerning between genders, has out-of-the-box support for matching across and between non-binary genders (as opposed to a heteronormative system providing only female-male matching). This is important, as we strife to be as inclusive as possible with this app and therefore it is necessary to support all sexual preferences and genders. Another reason is that out of the alternative algorithms mentioned, by implementing negative preferences RECON is capable of preventing rejections (as the system learns what attributes a user dislikes and can avoid those). And finally, RECON is a simple algorithm and is therefore easier to implement and oversee.

RECON calculates compatibility scores, based on an active user's interaction behavior and their profile attributes, and uses those to suggest other users. A distribution of profile attributes is created for each user, based on which their preferences are modeled. These distributions are generated based on the profile attributes of other users' profiles that an active user has shown interest in (by messaging or liking them). In order to avoid rejections, the system also keeps track of all the profile attributes that a user does not like. This is done by aggregating the profile attributes of users that were rejected by an active user.

It is important to note that RECON was tested in an environment where a user can send a short message to declare their interest, which then can be replied to or ignored by the other user [17]. For our dating application we envision something more akin to Tinder, were users can like or dislike others, and can only initiate a conversation with a user that has reciprocally liked them back (they are then considered a match). This means that our system can not only use messaging behavior, like in the original RECON, but also use swiping behavior as implicit data to build a preference model. Research could indicate whether or not the preference model should be built on both of these interaction data sets - and if so, if they should have equal weights in the equation - or if it is better to generate the preference model based on solely messaging history or swiping history. Although that is outside of the scope of this specific project.

4.2 Algorithm and Recommender User-Model

This section describes our proposed algorithm. The (modeled) user data is also reflected on in the B section of figure 1.

Take into account all users with whom user U has interacted positively with and extract the interests (Fig. 1 B5) of these users as a collection of counts. A positive reaction from user U being one of the following:

(1) User U liked (swiped right on) a user V (Fig. 1 B3);
(2) User U initiated contact with a user V (i.e. sent the first message) (Fig. 1 B1);
(3) User U replied to a user V who initiated contact with them (Fig. 1 B2).

This collection of counts, per attribute, can then be used to generate the positive preference model M_U^+. From this, the positive compatibility $C^+(U,V)$ of a user U (Fig. 1 B6) with another user V can be calculated by checking the amount of times each interest (Fig. 1 B5) of user V appears in the positive preference model M_A^+ of user U. These values are normalised by the number of users that were used to generate the preference model as well as by the number of interests that the user has on their profile. This is shown in formula 1, where att_n is the amount of times an attribute n from user V appears in M_U^+, $users_{M_U^+}$ is the number of users used to generate preference model M_A^+ and And V_A is the number of attributes that user V has on their profile.

$$C^+(U,V) = \frac{att_1 + att_2 ... + att_n}{users_{M_U^+} \times V_A} \tag{1}$$

Similarly, a negative preference model (Fig. 1 B7) for a user U M_U^- can be generated based on the interests found on the profiles of all users that they interacted negatively with. A negative interaction being:

(1) User U disliked (swiped left on) a user V (Fig. 1 B4); or
(2) User U ignored a user V who initiated contact with them (Fig. 1 B2).

The negative compatibility of two users U and V can then be calculated $C^+(U,V)$ by comparing the count of attributes in M_U^- to those found on the profile of the other user V in the exact same way the positive compatibility was calculated. This is shown in formula 2.

$$C^-(U,V) = \frac{att_1 + att_2 ... + att_n}{users_{M_U^-} \times V_A} \tag{2}$$

Once the system knows both the negative and positive compatibility of a user U and V, it can combine these with a user U's preference models by subtracting the negative compatibility score from the positive compatibility score and normalising it to obtain a value between 0 and 1 using formula 3.

$$C^\pm(U,V) = \frac{1 + C^+(U,V) - C^-(U,V)}{2} \tag{3}$$

This combined score results in high values when there is a match between the positive preference model of user U and the interests in the profile of user V, and a difference between the interests on user V's profile and the negative preference model of user U.

Recommendations for a user U, that are likely to be reciprocal, can then be made based on the harmonic mean of the combined compatibility scores. This is done to bias the lowest score, as this is often the determining factor in a reciprocal relationship. E.g if user U likes user V (high score) but user V does not like them back (low score), that is a deal-breaker. The resulting formula can be found in formula /refeq4:

$$C^\pm_{rec}(U,V) = \frac{2}{\frac{1}{C^\pm(U,V)} + \frac{1}{C^\pm(V,U)}} \tag{4}$$

The top-N scoring users are then filtered based on the user search preferences, age (Fig. 1 B9), sex (Fig. 1 B11.) and location range (Fig. 1 B13) and shown to the active user. These filters are applied based on the explicitly specified age (Fig. 1 B8) and gender (Fig. 1 B10) of the user, and the implicitly obtained current location (Fig. 1 B12) of the user (through phone location tracking data).

This provides the system with a simple and easy to implement recommender which is able to cater to the individual preferences of a user, based on their past behavior and supply them with personalized recommendations. One downside to the use of this algorithm is the presence of Cold-Start, due to the fact that the system relies on user interaction data, which for new users, is not yet present. A potential remedy to this could be to have the system use the profile attributes of the active user and gradually reduce their weight in the preference model as interaction data becomes more present.

5 INTERFACE AND INTERACTION

The aim of this system is to be an accessible system, as defined in section 2. This coming section will first describe the regular features of the system, followed by the different user-based adaptations. The regular features of the application have been designed with the W3C guidelines and AccessGuide guidelines in mind [10] [19]. These guidelines partly overlap, and not all are useful or relevant for the system under design. The most important ones that are used are:

- Information and user interface components must be presentable to users in ways they can perceive. Meaning text alternatives for non-text content - such as images and icons - must be provided, and content has to be easily distinguishable through clear contrasting and use of easily readable fonts.
- User interface components and navigation must be operable, and must not be designed to cause seizures.
- Information and the operation of the user interface must be understandable, so all text is readable and easily understandable by not using convoluted language, and the application behaves in a predictable way.

Specific pages and features will be made further accessible based on the disability groups as described in Section 3 (visual, physical, cognitive/neurological, and auditory). Some of these overlap, and some are incompatible with each other, so the user can select which accessibility features they want themselves when creating an account and afterwards in the setting. The pages/features can be seen in Figure 2, colour-coded based upon which disability group the page is made further accessible for; e.g., a blue dot means the page is made accessible for visually impaired people. These changes will be detailed per page.

Create account: After starting the app, the user is presented with the log-in screen. A users that has no account has to create one. Creating an account is adaptable for visual, physical, cognitive/neurological, and auditory impairments. As the on-boarding of a new user is the most important part to make the app accessible, a mock-up is created and can be found in appendix C, Figure 3.

During the on-boarding the system will always give both visual and auditory feedback. Users that cannot physically click on the screen (e.g. visually impaired who cannot see, or physically impaired who have no/limited motor functions in their hands) can use speech commands to use the app, the system will automatically ask if this is needed after a short delay, as seen in C2. Users who can click the screen will have the option to customize the app based on their needs. It is possible to adapt to peripheral vision (C3), change contrast (C4), enable colourblind mode (C5), Swap to dyslexic font (C6) and enable/disable audio feedback (C7). These settings will be saved, and the rest of the app will apply them.

Make profile: After the first log-in, the user has to make a profile. Here, they can add pictures and write a bio to describe themselves. The settings that the user chose during account creation will be applied here. Users are asked to add a description of their pictures, so it will be more accessible for visually impaired users.

Log-in: The log-in screen is used when the user has already made an account. It is possible to enable fingerprint scan verification for a more secure account. However, since not everyone can do this, it is also possible to enter a password, either by typing it or by using voice commands.

Homepage/Pairing matches: Once the account has been created and the preferences are set, the user is greeted with the homepage. On the homepage, the user can navigate to different pages such as the Settings, the profile and the interactions with matches. To adhere to normal design patterns the navigation can be done via a bar at the top of the screen [19]. However, the main purpose of this page is the pairing with potential partners.

As all other pages, this and following pages after log-in can also be navigated by voice commands and can also be read aloud by the system. However, more inclusivity changes have to be made to the matching. The matching of potential partners in a normal application heavily relies on visual appeal. As not all users can see that well, it is also possible to get a summary of the image in text or sound [10]. To further bolster non-visual pairing: a set of likes and dislikes is also given. These, as described in the algorithm section, also have an impact on who are shown to the user.

Interacting with matches: Users that have been matched are able to communicate with one another. This is mainly done via texting. However, visually and physically impaired people might have a hard time interacting in this way [4]. To make it more accessible the application has to support audio messages. Audio messages can easily be sent to each other in the same way WhatsApp or Facebook messaging does. However, this type of communication brings the added problem of people with auditory impairment that are not able to listen to these messages. To counteract this, the app supports speech-to-text conversion and text-to-speech synthesis.

Settings: The settings show all options that are described in the *Create account* section in a listed manner. All accessibility features can be easily changed and tweaked if needed or as impairments worsen. On top of those, all general settings like notification settings and log-in credentials can be changed. In the settings, an extensive privacy statement about the algorithm can be found. The same goes for the user data; especially data about impairment settings and the general privacy surrounding the sharing of content.

6 EVALUATION

Evaluation is the systematic determination of merit, worth, and significance of something or someone [3]. It is important to evaluate the application during multiple design phases, in order to make the interface as accessible as possible. In our case, it is also important to measure satisfaction of the outcome of the application, i.e. the matched pairs, since we use a different algorithm for this than we do for adapting the interface. In addition, there are three main evaluation paradigms according to [20]: (1) user studies; (2) online evaluation and (3) offline evaluation. We will mostly use online evaluation, both for the evaluation of the accessibility of the interface as for the evaluation of the satisfaction of the outcome.

In [20], five different evaluation goals are described: (1) accuracy; (2) serendipity; (3) diversity; (4) user satisfaction with items or the system and (5) fairness. As mentioned in the previous section, our evaluation focuses mainly on user satisfaction, so the fourth goal. This is because our research question is mainly related to accessibility and also to satisfaction with the outcome. In order to measure this goal, we will conduct a multi-method evaluation. The multi-method evaluation will be used because it is not only restricted to a combination of qualitative and quantitative evaluation [6], but the focus is more on the evaluation itself. Since the main research goal is to find out how a dating app can be made more accessible for people with disabilities, the evaluation will focus on the interface these users will interact with, and not the recommender algorithm.

There are several designs for multi-method evaluation: (1) the convergent parallel design, (2) the sequential design, (3) the embedded design and (4) the multi-phase design [6]. For our multi-method evaluation we use the multi-phase design, in which we created two phases. In the first phase, we use the embedded design and in the second phase we use the convergent parallel design. The model of this multi-phase evaluation design is presented in Figure 4 in Appendix D and will be described in the following sections.

At the basis of our evaluation lies a mock-up of the app. This mock-up would be presented to a focus group to gather initial qualitative data about the functioning of the app (Fig. 4 M1). The focus group would exist of people with the disabilities our app caters to. Ideally there are at least ten people present for each disability that should be tested. They would be given a task specifically targeted towards their disability in relation to navigating the application. Users would be monitored as they try to complete the task. During the task, they would be asked to give feedback on the navigation and interface elements they encounter. Based on these finding, we know where and for which disabilities our application needs improvements. In addition to the qualitative data, we make quantitative measurements which assess how quickly the goal is reached (Fig. 4 M2). Doing this gains the researchers insight on the effectiveness of the specific adaptable feature. Later this data can be used for comparisons, to indicate if effectiveness is increasing, decreasing or staying the same. This can be used to conclude if progress is being made.

After the first part of the evaluation is completed, the app needs to be altered to remedy the limitations of the mock-up. For this, we will use the feedback provided by the users in the focus group. Furthermore, we will look at the speed and efficiency measurements to change the interface in places where users got stuck. After the app is built, evaluations need to be carried out to ensure an optimal user interface for our target audience. We propose to use an online evaluation for this in the form of a questionnaire with closed questions (Fig. 4 M3). The questionnaire is presented to users as a pop-up in the app. It will exist of a small number of questions meant to test the usability features and user satisfaction in the app. Additionally, we would still record metrics of users interacting with the app (Fig. 4 M4). Examples of this would be the time it takes to create a new account or the time spent on certain pages within the app. After interpretation of the data, this inform us of bottlenecks in the current design. Consequently, this information would be combined with the results from the questionnaire and used for reiterating the interface design.

7 DISCUSSION

This paper has shown that it is possible to cater to a broad spectrum of disabilities with regards to accessibility. There are numerous guidelines that describe how a system can be made more accessible. However, most of these guidelines focus on a specific disability. The system described in this paper utilizes a combination of different guidelines that are relevant for the design at hand, to lead to a higher level of inclusivity. It is hoped that this paper shows the merit of this approach, and that it becomes 'good practice' among developers, leading to a higher level of inclusivity across the entire web.

The application described in this paper differs from other systems that have been reviewed in numerous ways. Compared to regular dating apps, it offers more accessibility features, making it usable for a large group of people who have historically had difficulties using the internet as a whole, but especially dating apps. Furthermore, compared to dating apps that focus on disabled people, the app offers more adaptivity. It is possible to personalize the accessibility features based on personal needs, rather than a one-size-fits-all approach that other apps use. These kinds of apps also are often aimed at disable people, without actually catering to their accessibility needs.

7.1 Limitations

Despite its merits, this paper and the designed system do not come without limitations. First of all, most design choices are based on literature only. Involving users from the start and gaining their insights might have lead to a more robust solution. To minimize the impact of this, multiple different guidelines are used, and users are involved in the evaluation phase, to hopefully come to a robust solution as well. Additionally, the categorization of disabilities in groups that is made in this paper is also done based on literature only. It might be possible that this is not exhaustive, and that certain disabilities are not catered to. This, in turn, can lead to more isolation among this group. However, there seems to be a consensus in the literature that these are the main groups. Moreover, this categorization is used because otherwise it would become virtually impossible to cater to every individual disability.

Furthermore, if the application actually were to be made, it might be difficult to market it. The app would benefit from having a larger user-base, since this would lead to more and better potential matches. Because disabled people are only a small subset of the population, the app would rely on attracting non-disabled users as well. However, since disabilities are often stigmatized it might be difficult to attract a sufficient amount of users. Since this is a societal problem, there is no easy solution. However, by offering an inclusive shared space on the platform this stigma can hopefully be be reduced.

Another issue is that disabled people can often be vulnerable online, especially people with cognitive/neurological disabilities. The app does not offer ways to protect these people. While this was considered, possible solutions also have drawbacks. For example, through monitoring conversations, bad actors could be identified and banned from the platform. However, this would be very intrusive, and conversations on dating apps are often very personal. Furthermore, it would also be a time and cost intensive process. Ultimately, the decision was made to leave this outside of the scope, but further research could be done into this area.

Finally, the app relies on outside technologies for parts of its functionality, such as text-to-speech and voice commands. The quality and reliability of these technologies might not be satisfactorily, and little research was done into their inner workings. This is also something that would benefit from further research.

8 CONCLUSION

This paper aimed to research the question: *How can a dating app be made accessible for people with disabilities?*

Disabled people often face issues such as loneliness and isolation. This is partly caused by a lack of romantic relationships. Little research has been done into accessibility of dating apps. Current dating apps that are targeted at people with disabilities are often limited in their adaptability on said disability. The proposed application is developed as accessible by design. This design system uses accessibility as the starting point of the interface development. Its basic design is made based on multiple guidelines for online accessibility. This is then further improved by adapting to the needs of specific user groups. Better adaptability leads to a higher amount of inclusion for as many disabilities as possible, which therefore leads to better accessibility for different users.

To measure the accessibility, the application is evaluated using multiple evaluation methods. The results can be used to improve the accessibility where needed. Once the application is finished, the main goal will be to use it to decrease the loneliness and isolation that disabled people often experience. Meanwhile, the application can still be extended and improved upon in order to further specify the adaptations for all the different types of users. In addition, the discussion points and limitations can be researched further upon as well, so the application and the accessibility of it keep improving.

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A USER MODEL

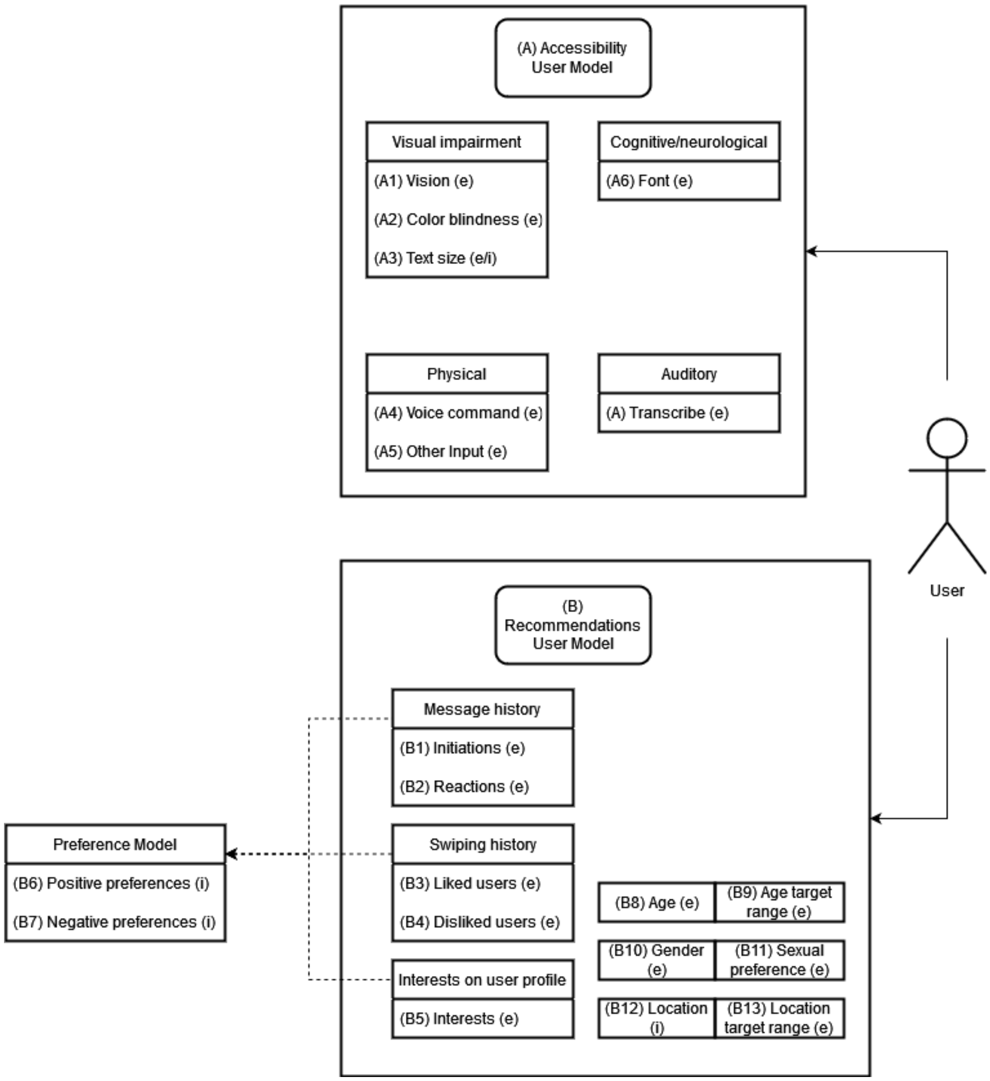

Figure 1: User model of both the information extracted for the adaptive interface and the recommendersystem

B GENERAL FLOW APPLICATION

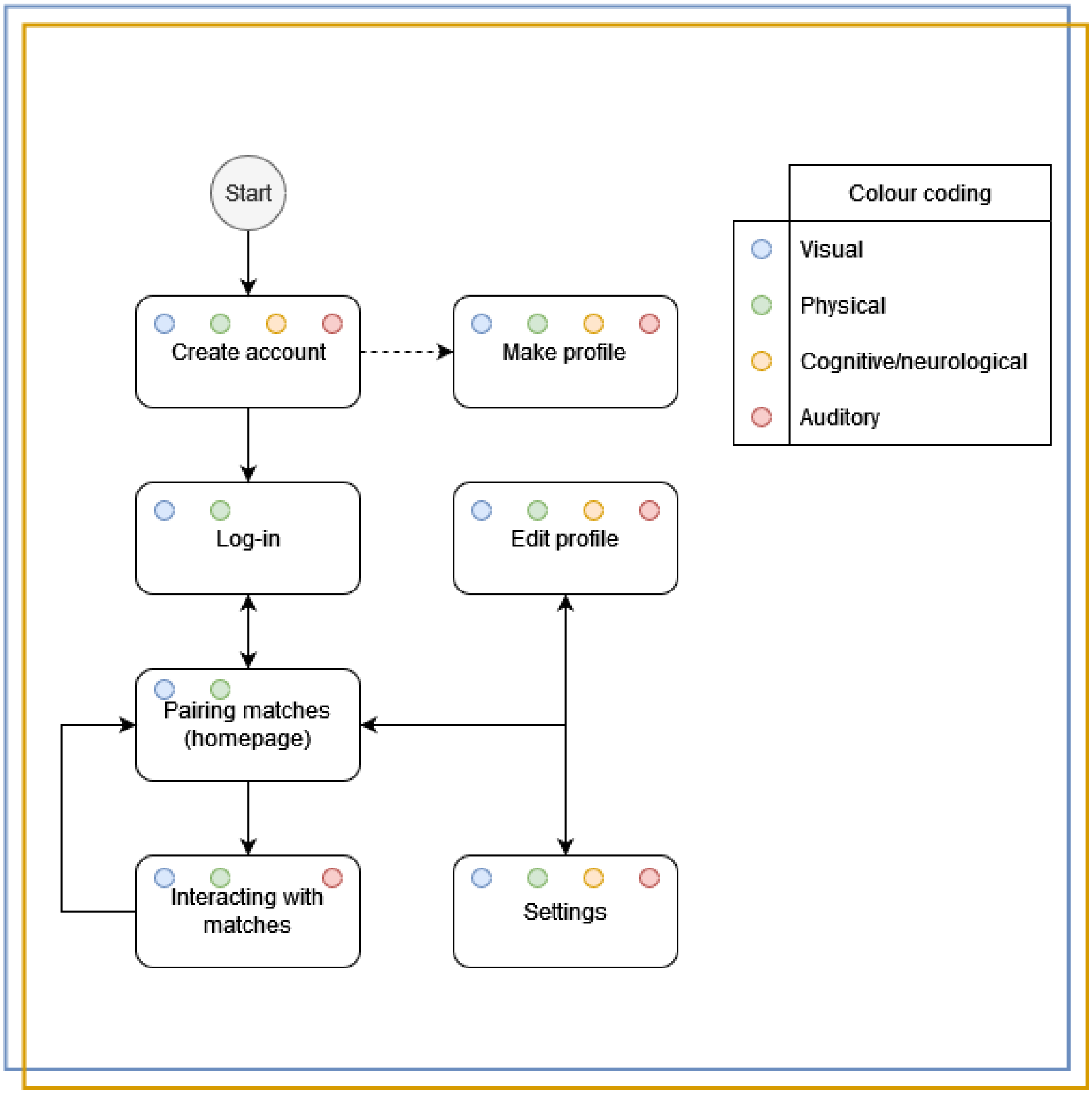

Figure 2: Flow application in a standard non-adaptive situation

C PROTOTYPE OF ON-BOARDING

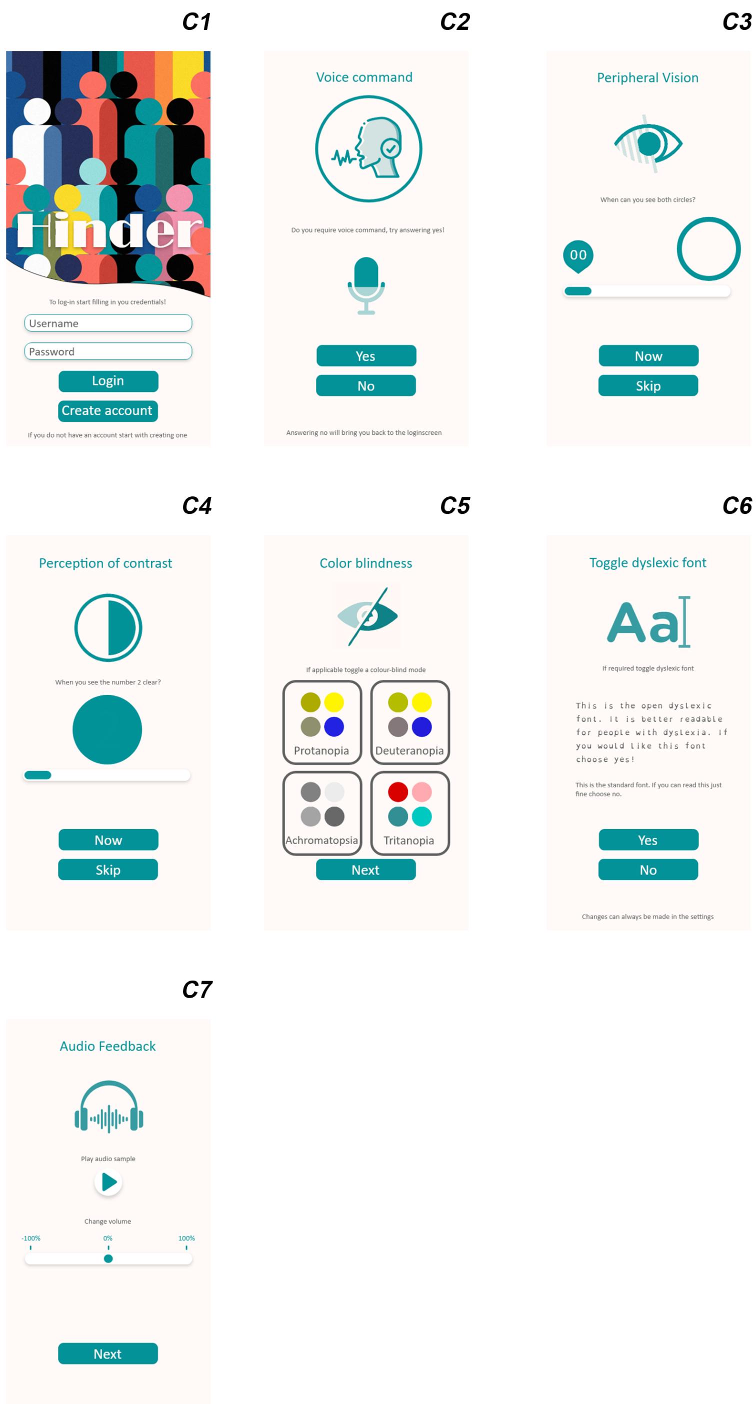

Figure 3: Prototype of on-boarding: login and six example screens

D EVALUATION MODEL

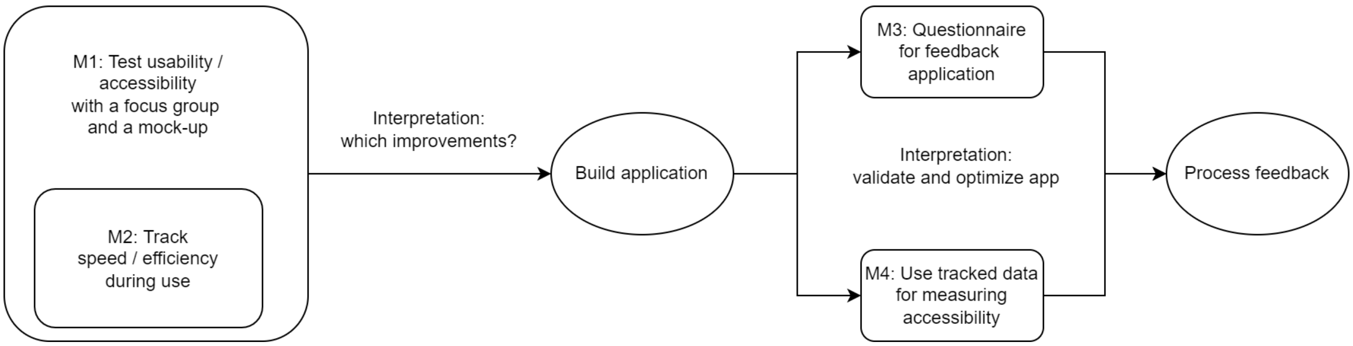

Figure 4: The multi-phase, embedded and convergent parallel designs