I Agree: Customize your Personal Data Processing with the CoRe User Interface

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Abstract. The General Data Protection Regulation (GDPR) requires, except for some predefined scenarios (e.g., contract performance, legal obligations, vital interests, etc.), obtaining consent from the data subjects for the processing of their personal data. Companies that want to process personal data of the European Union (EU) citizens but are located outside the EU also have to comply with the GDPR. Existing mechanisms for obtaining consent involve presenting the data subject with a document where all possible data processing, done by the entire service, is described in very general terms. Such consent is neither specific nor informed. In order to address this challenge, we introduce a consent request (CoRe) user interface (UI) with maximum control over the data processing and a simplified CoRe UI with reduced control options. Our CoRe UI not only gives users more control over the processing of their personal data but also, according to the usability evaluations reported in the paper, improves their comprehension of consent requests.

Keywords: Consent request · GDPR · Privacy · User interface.

1 Introduction

The General Data Protection Regulation (GDPR) as well as EU member state laws (e.g., Austrian "Datenschutzgesetz", German "Bundesdatenschutzgesetz", etc.) require, except for some cases[1], data subjects' consent for the personal data processing. The GDPR conditions the processing of personal data to a set of principles, among which is the principle of lawfulness (GDPR Art.5(1)(a)). The consent is listed as one of the lawful bases for data processing in GDPR Art.6(1)(a). What constitutes as legally valid consent is defined in GDPR Art. 4(11); complemented by GDPR Art. 7, when it comes to the conditions of consent; and clarified in the Article 29 Working Party Guidelines on consent under Regulation 2016/679. According to said sources, the consent of the data subject should be: (i) *freely given*, i.e., it provides real choice and control for data subjects; (ii) *specific*, i.e., it is separate from information about other matters, is tied to a purpose, and provides separate opt-in for each purpose; (iii) *informed*, i.e., it includes elements that are crucial to understand personally identifiable information (PII) processing and make a choice; and (iv) *unambiguous indication of the*

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[1] In GDPR such cases are defined in Article 6(1)(b-f).

data subject's wishes by which they, by a statement or by a clear affirmative action, signify agreement to the processing of personal data relating to them.

One of the key challenges is the development of consent user interfaces (UIs) that adhere to said requirements, while being mindful of the potential for cognitive overload from the data subjects perspective [15]. Currently the predominant mechanism for obtaining consent is to present the data subject with a verbose description of the current and future data processing, where processing is described in some very general terms. Although there are a couple of papers that examine consent in the form of notice and choice, whereby data subjects are provided with more transparency and control [1,4], we highlight that the cognitive limitation of end users is a major issue, which needs to be addressed.

In this paper, we present our consent request (CoRe) UIs, that, to some extent, overcome such cognitive limitations. Although our UIs could be used for a variety of applications, in this paper they are tailored to our exemplifying use case scenario, whereby a young business administration student purchases a wearable appliance for fitness tracking and wishes to control how her data are used. Our use case is based on the GDPR because the GDPR provides concrete and legally binding requirements for consent, however, this does not preclude the CoRe UIs from being used all over the world. Companies outside the EU also have to comply with the GDPR and obtain a valid consent, if they want to process personal data of their EU citizens. The attributes of the consent request that form the fundamental basis of the CoRe UIs are derived from the GDPR and questions routinely asked by lawyers when they are charged with assessing the lawfulness of personal data processing in the EU: (i) the type of personal *data* collected from the data subject; (ii) the *processing* performed on the personal data; (iii) for what *purpose* the data are processed; (iv) where the data are *stored* and for what duration; and (v) if the data are *shared* who are the recipients.

The contributions of the paper can be summarised as follows: (i) we propose CoRe UI with maximum control[2] over the data processing and simplified CoRe UI[3] with reduced consent customization options; (ii) we conduct user evaluations of the proposed interfaces and provide pointers for addressing the uncovered shortcomings in terms of usability and understandability. The remainder of the paper is structured as follows: *Section* 2 provides an overview of the state of the art. *Section* 3 presents our use case scenario and provides an overview of the methodology used to guide our work. *Section* 4 describes CoRe UI, which has been designed for maximum control, and the respective user evaluation. *Section* 5 details our simplified CoRe UI and the corresponding user evaluation. Finally, we present our conclusions and identify directions for future work in *Section* 6.

2   Related work

Consent can be viewed in terms of a spectrum ranging from *no consent* to *blanket consent* [20]. Where, *no consent* means that all data usage is prohibited;

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[2] The online version of the prototype is available at: https://bit.ly/2Z1yrKs.

[3] The online version of the prototype is available at: https://bit.ly/2U6TkQw.

specific consent means that consent must be tightly coupled with the purpose or context; *dynamic consent* provides autonomy and transparency to data subjects with respect to data usage; *broad consent* involves consenting to a framework whereby data are categorized according to type and ethical monitoring is used to determine if new processing is relevant under the existing framework or if additional consent needs to be provided by data subjects; and *blanket consent* refers to the granting of virtually unlimited (including future) use of the data. As for consent in more general settings, much of the focus to date has been on privacy policies as opposed to consent interfaces, however, it is well known that users regularly agree to privacy policies without actually reading them. One potential explanation is the time and effort required to go through such policies in detail [15]. Other literature, related to obtaining consent from the data subjects, concentrates on analyzing privacy control UIs, such as app permissions [23,13]. When compared to a consent request, app permissions only provide users with an overview of the type of access the app requires. No information is provided about what could be done with the data, for example, in the background; where the data are stored; how they are processed, etc.

In terms of privacy policy visualization, Friedman et al. [9] describe their cookie-watch tool that should improve users' understanding of cookies and their management. However, they still use text, as in classical privacy policy, to provide details on cookies to the users. Kelley et al. [12] describe the process for constructing privacy policies based on labels. Although, based on their evaluation, the label approach helps users to find information more quickly and accurately, they fail to visualize the full data flow. Costante et al. [8] offer a solution to browse the privacy policy content and automatically assess its completeness. Though they group privacy policy content into categories, the text of the privacy policy still remains the same as in a typical privacy policy.

As for general analysis of privacy policies and notices, McDonald et al. [16] contrasted six companies' privacy policies and evaluated layered policies, privacy finder reports and conventional human-readable policies. They report that all formats and policies were similarly disliked. Schaub et al. [18] survey the literature on privacy notices and identify challenges, requirements and best practices for privacy notice design. Google's and Facebook's approaches to obtaining consent, according to a Norwegian Consumer Council report[4], employ dark patterns that trick users into providing consent for the processing of more information and intentionally make it harder to customize users' consent.

Although the GDPR provides some guidelines in terms of obtaining valid consent, one of the key challenges is the development of consent interfaces that satisfy relevant requirements of the GDPR, while at the same time being mindful of the potential for data subject cognitive overload. In this paper, we explore two consent request UIs, and evaluate their effectiveness not only in terms of usability but also with respect to the understandability and task performance.

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[4] Norwegian Consumer Council Report. https://bit.ly/2N1TRRC.

3   Background and Methodology

Before describing our CoRe user interface prototypes and the respective usability evaluations, we first provide the necessary background information with respect to our exemplifying use case scenario. Following on from this we present the methodology used to guide our work.

3.1   Exemplifying Use Case Scenario

For the development of our CoRe UI prototypes we used the following exemplifying use case scenario. Sue, a business administration student, buys a wearable appliance for fitness tracking from BeFit Inc. To be able to use the device's features she has to agree to the processing of her data. She browses to BeFit's website and is presented with a BeFit's consent request that is using the CoRe UI. For the purpose of our research the content for the CoRe UI was derived from the analysis of four smart devices (FITBIT, Apple Watch, GARMIN Vivomove, and GARMIN ForRunner) and two cloud based analytic services (Runkeeping and Strava).We use a representative data flow for our use case and, as a result, also for the CoRe UIs. Thus, there is no need for a highly complex use case for the purpose of the initial UI design and subsequent usability evaluations.

3.2   Methodology

Our UI design process is guided by Action Research (AR) [7]. AR is an iterative process where the problem is first identified; then, action is taken to solve it; and in the end, the outcomes of the action are evaluated. If the evaluation results are not satisfactory and the proposed solution is not well received, the solution is improved taking into account what was learned from the evaluation. This process continues until the problem is solved or the researcher concludes that solution cannot be found.

In order to make our usability evaluations as realistic as possible, as opposed to those performed in lab settings, we developed online prototypes to remotely test the usability [22] of our CoRe UIs, as that enabled the participants to give their consent from any place comfortable for them. Additionally, we ensured ecological validity [5] by: (i) deriving the content for the consent from the popular wearable appliances for fitness tracking; (ii) developing cross-platform prototypes that allowed users to test them on any device, operating system and browser of their choice; and (iii) testing our prototypes with a broad segment of population. We selected an observational method to test usability of our prototypes because we wanted to focus more on the why and how aspects of the user interaction, rather than on what, where, or when [14]. The evaluation of our UIs was done in an asynchronous remote way [2] using a think aloud method [19,6], where users recorded the video of their screen, combined with performance measurement [11] and post-evaluation remote questionnaire [10].

Before the actual UI testing started, the respondents were asked to imagine themselves buying BeFit's wearable appliance for fitness tracking. As a second

step they were presented with BeFit's information about the consent request. After the participants read this information they were asked to activate the device, in order to start the process of giving their consent for the processing of their personal data, and were forwarded to the CoRe UI prototype for the actual evaluation. During the usability evaluation, the participants first completed a set of predefined tasks, that allowed us to measure the performance of the UI. After these predefined exercises, they were asked to simply give their own consent, as they would have done if they bought the BeFit smart watch: "Now, that you got acquainted with how the consent request works, please imagine that you decided to use the BeFit device and give your consent according to your own preferences." Users' own consent was used to assess if participants understood what they consented to. The participants recorded the video of their screen and the audio of their spoken thoughts during the whole assignment. Additionally, all the interaction of the users was recorded into the log file. After finishing their assignments, each participant filled in a questionnaire[5] containing single choice, multiple choice, rating scale and open-ended questions providing us with their demographic data as well as their impression of the CoRe UI. In the questionnaire the users were prompted to select adjectives that they would use to describe the UI prototype. We used the list of adjectives from Microsoft Desirability Toolkit, developed by Joey Benedeck and Trish Miner [3]. Since the original list consists of large amount of words, it is recommended to shorten and adapt the list, which we did in our usability evaluation.

4   CoRe UI with Maximum Control

Generally speaking, current consent requests follow all or nothing approach, where users either agree to the whole data usage policy or they cannot use services and devices. In our first UI prototype we decided to start at the other extreme and gave users full customization possibilities for their consent to data processing. We based the functionality of the CoRe UI on the GDPR requirements (see *Section* 1) adapted to the BeFit use case introduced in *Section* 3. Figure 1 depicts our first CoRe prototype for BeFit's consent request. To make our prototype more realistic and more suitable for usability testing, we developed its fully functional online version[6]. The source code of the prototype is available online[7] for a review. The design of the UI was guided by Jackob Nielsen's usability heuristics for user interface design [17]. From a technology perspective, we used Angular Material and D3.js for the front-end development of the online version and Firebase, with its real-time database and hosting, for the server side.

4.1   CoRe UI Prototype Description

The first version of the CoRe UI prototype incorporated the following features: *Categorization.* We grouped information according to the five categories, namely

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[5] Our questionnaire is available at: http://tiny.cc/z6d14y.

[6] The online version of the prototype is available at: https://bit.ly/2Z1yrKs.

[7] The source code of the maximum control UI is available at: http://tiny.cc/rh2z4y.
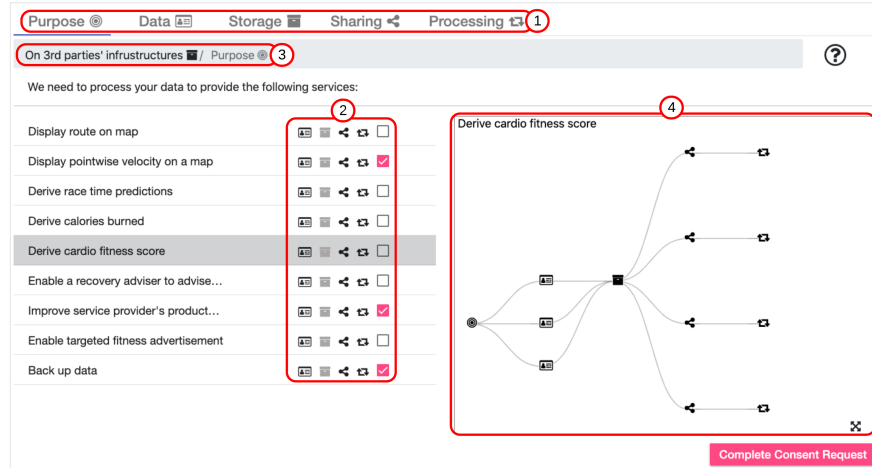
Fig. 1: CoRe UI prototype that offers maximum control to the data subject. (1) Tabs. (2) Drill down. (3) Breadcrumbs. (4) Graph.

purpose, data, storage, sharing and processing, which could be used by customers to understand how their data are processed and with whom they are shared. This grouping is realized in the form of tabs (see Figure 1 (1)). We chose this interaction design pattern to lessen the complexity of the interface and the information overload from the content of the consent request. Tabs are broadly used in desktop interfaces and websites, so that users aren't confused by the way they work. Additionally, grouping in general is a very effective way to declutter the interface [21]. To support the UI interaction, in addition to the name of the category on the tab, we added icons for each category. In the purpose tab, we display the services that are offered by BeFit that require personal data processing. The data tab lists personal data that could be processed by BeFit, if the user consents to data processing. In the storage tab we provide information on where BeFit stores the data subject's data. The sharing tab gives insights into third parties with whom BeFit may share personal data of the data subject. In the processing tab we describe how personal data could be processed.

Customization. The most prominent feature of our first CoRe UI prototype is the full customization of data subject's consent. In contrast to the usual all or nothing approach, the user can fully adjust their consent specifically to their wishes. Our consent request gives the possibility to review information or give consent according to the five categories mentioned in the categorization feature above. Any tab category can be a starting point for giving consent. The user is also given the possibility to drill down a concrete path and agree only to that path. This means that the data subject can also give permission to process only specific data categories for chosen purposes, etc. For example, users can allow BeFit to process their resting heart rate (data) to be displayed to them in BeFit's app (purpose) by performing on-device calculations (processing) and saving the

data on their device (storage) without sharing it with anybody. The drill down feature is implemented by placing clickable icons of possible drill-down options near each item in the tab list (see Figure 1 (2)). Icons are especially effective when there is not much space available[8]. The users can drill down through each item in the list by clicking on an icon that corresponds to the category they want to select. In this way the users can create a unique path to consent to. The unique path is displayed and can be navigated with the aid of breadcrumbs that are displayed under the tabs (see Figure 1 (3)). This design pattern helps users to know where they are at all times. Breadcrumbs are especially important when a drill-down process is involved. This pattern is often used for filtering and in the applications with hierarchical structures [21]. The users give their consent just by selecting checkboxes (see Figure 1 (2)) that correspond to their preferences. The check box is placed near each category item beside the icons for the drill-down options. We elected to go with checkboxes as they are simple, consume little space and the choices are immediately visible to the user [21].

Understandability. To increase understandability and ease of use of the consent request we are using plain language and standard icons for the content. Every user action is backed up by feedback. To help the data subjects understand the implications of their consent, our consent request is supported by a graph (see Figure 1 (4)). The graph has a tree form and shows every possible unique path that goes through the selected item. The paths that the user consented to are highlighted in red. Each item in the graph is represented with the help of already mentioned icons. More information, in the form of a tooltip, is shown upon hovering over each icon. The user can also enlarge the graph to full-screen size by clicking the corresponding button in the lower right corner. By trying out different organizational models that are typically used to represent hierarchies, we decided that the graph was the most suitable model for our content. We also added a summary feature to our prototype. After users finish consenting, they are presented with an overview of all the information relating to the consent they had provided to BeFit.

Revocation. According to GDPR Art.7(3), the data subjects should be able to withdraw their consent for future processing and sharing of all (or a part) of their data at any time and the withdrawal of consent should be as easy as granting it. CoRe UI enables users to withdraw their consent at any time by removing the selection in a checkbox (see Figure 1 (2)). In our use case the consent is given for the first time before using the device and the consent withdrawal in our interactive UI wireframe is tailored to this use case.

4.2   Results of the User Evaluations

In order to gain feedback from real users as to the effectiveness of our interface we conducted a usability evaluation of the CoRe UI. Our participants were recruited among students who attended a course entitled "Intelligent Customer Interaction Design" for the first usability evaluation. This sample of participants

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[8] Welie.com, Patterns in interaction design. https://bit.ly/2uWvFsf.

suited well for the evaluation, because the persona (Sue) in our use case scenario was a student. This evaluation provided us with the initial feedback. In subsequent usability evaluations we planned to test the improved versions of CoRe UI prototype with a broader segment of the population.

Twenty-seven participants, between 16 and 35 years old, took part in our usability evaluation. Most of them graduated from high school and have either information technology or education as their background. 63% of the participants are male and 37% are female. The participants consider themselves competent, proficient or experts in Internet surfing. Almost half of the participants (44%) spend 3-6 hours on the Internet and only 4% spend less than one hour. All participants have no difficulty using computers and half of them prefer laptops for Internet browsing, 32% preferably use desktop computers, only 11% would choose smartphones to surf the Internet and 7% would use tablets.

During the evaluation, the participants, first, completed a set of predefined tasks[9]. Then they gave their own consent, as they would have done if they had purchased the BeFit smart watch. The assignments were video recorded. After finishing their assignments, the participants were automatically redirected to a questionnaire where they answered rating scale and open-ended questions regarding their experience. The results of the analysis of the video recordings and the questionnaire answers are described below.

Video recordings. The analysis of the 27 video recordings provided by our participants showed that having the option to customize everything was very time consuming, annoying and confusing. 74% of the participants were confused by the drill-down process and as a result did not complete the tasks correctly. Although the participants understood the icons and recalled their meaning very well, they did not understand that the drill-down functionality was only available via icons and kept using icons and tabs to drill down interchangeably, thinking that both approaches could be used to create unique paths for their consent. 22% understood the creation of the unique path partially and only 4% completed the assignment successfully. The participants required, on average, 15 minutes to finish all the tasks and another 15 minutes to give their own consent.

Comprehension testing. To assess if participants remembered and understood what they agreed to, we asked users in the post-evaluation questionnaire to describe what they consented to in the previous task where they elected what they would personally consent to. Since the participants were confused by the functionality and overwhelmed with the customization options, 96% did not describe correctly what they consented to and, therefore, gave their consent without understanding what they were consenting to.

Time perception. When asked to assess the time it took to give or withdraw the consent, the users confirmed our video recording observations about time consumption. Almost half of the participants (48%) answered that it took them too long to give or withdraw the consent. 22% selected too long, but it was worthwhile as their answer. For the rest of the users it took either less time (11%) or about the right amount of time (19%).

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[9] Usability evaluation tasks are available at: https://bit.ly/2IaRUDk.

Adjective description. Unsurprisingly, a lot of the users (67%) found the UI prototype "complex" and the whole process "time consuming". 55% of the participants found the consent representation to be "confusing". For 52% of them the UI was "hard to use". 44% of the users thought the UI was "annoying" and 41% were "frustrated" when using the CoRe UI prototype. Apart from the negative adjectives, we also received some positive feedback. 33% of the participants described the UI as being "organized", 30% as "effective", 26% as "innovative", 22% as "flexible" and 19% as "valuable".

Prototype vs traditional consent request. When comparing our prototype to the classic consent request in the form of privacy policy and an "Agree" button at the bottom of the web page, a lot of the users highlighted that they liked the flexibility and customization features (e.g., I liked that: "I could choose", "I could change the settings", "I could actually decide...", "I was able to shape everything to my needs", "I could withdraw the consent at any time"). The respondents mentioned that they found the graph functionality very useful and they liked the summary in the end of the process of giving their consent. The participants replied that they liked the readability of the consent (e.g., "I liked the language - there were no problems understanding the consent request"). The users also mentioned that they found the division of information into tabs very good, because it provided some structure and contributed to understandability (e.g., "Everything is clear structured").

Ease of use. The participants named four features that were the easiest for them to use, namely the graph, the summary, the tabs navigation and the structure, as well as giving and withdrawing consent. The hardest part was not to be lost in all the options available to the users. Many of the participants also mentioned that it was the hardest to keep all the information in mind.

Tab usefulness. Since we anticipated that providing very detailed information to the users and giving them such a detailed control over the data processing would be overwhelming for them, we included a question in the post-evaluation questionnaire regarding the usefulness and importance of the information provided by the tabs, in order to identify which tabs could be, for example, hidden in the UI and shown only on demand or removed from the customization options. 35% of the participants think that information on all tabs is important. 38% voted for the tab *processing* to be removed.

Graph. We asked the participants two questions regarding the graph to find out if they understood it and if they found it useful. For the most of them the graph was slightly, moderately, very or extremely understandable (78%) and useful (70%) (e.g., "The graph was the only thing I really understood", "A very nice form to give the overview"). 22% of the users could not understand the graph and 30% found it to be not useful.

Overall satisfaction. When we asked users if they were satisfied overall with the UI prototype, 41% of the participants reported satisfaction (11% - very satisfied, 30% - somewhat satisfied). 15% of the users remained neutral towards the consent request, 44% of the participants were not satisfied (33% - somewhat dissatisfied, 11% - very dissatisfied) with our UI prototype. The question "how well
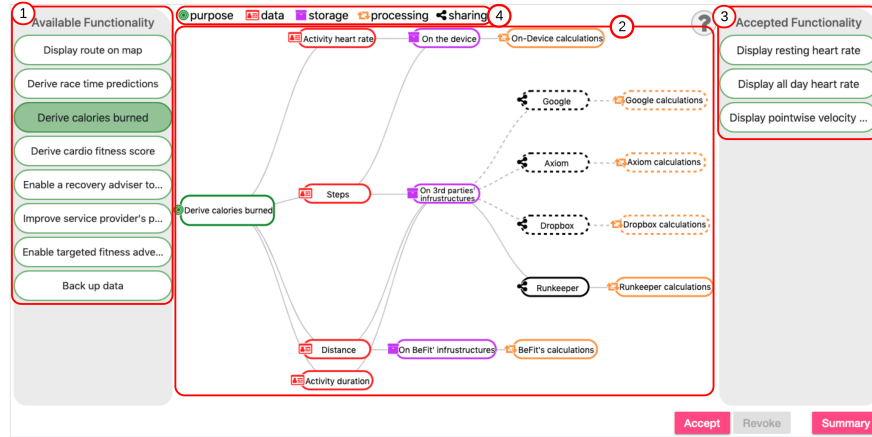
Fig. 2: The simplified CoRe UI prototype.(1) Functionalities to select from. (2) Required data processing for the selected functionality. (3) Accepted functionalities. (4) Color-coding by data category.

the consent request meets your needs?" received only 15% of negative answers. Most of the users selected somewhat well (41%), very well (29%) or extremely well (15%) as their answers.

Prototype improvement suggestions. The main reasons why one might not use our consent request, according to the usability evaluation, are information overload, complexity and too detailed customization. Since a lot of the participants were overloaded with the information, they suggested simplifying the information representation, offering fewer options to choose from and using color-coding.

As can be seen from the evaluation results, the data subjects were overwhelmed with such detailed consent information and with too much control over their data processing. Thus, highlighting the fact that there is a clear need for the simplification of the UI prototype and the reduction of the consent options.

5 Simplified CoRe UI

We developed a second CoRe UI prototype taking into account the evaluation results of the first version. Since the graph functionality was well received by the users in our usability testing, we decided to use the graph as the basis for our next version of the CoRe UI. The second version of the CoRe UI is depicted in Figure 2. For the purpose of the second usability evaluation we developed an online prototype with two localizations: English[10] and German[11]. The source code of the prototype is available online[12]. As before, we used Angular Material

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[10] English version of the prototype is available at: https://bit.ly/2U6TkQw.

[11] German version of the prototype is available at: https://bit.ly/2G2V6gR.

[12] The source code of the simplified UI is available at: https://bit.ly/2uWtHYM.

and D3.js for the front-end development of the online version and Firebase, with its real-time database and hosting, for the server side.

5.1 CoRe UI Prototype Description

The participants of the first UI evaluation liked the categorization of the consent information into purpose, data, storage, processing and sharing, so we kept this categorization in the second version of the UI. They also highly appreciated the customization and the flexibility of the consent request. However, they expressed their frustration with too many options. In our second CoRe UI prototype we retained the customization feature, but we reduced the options by presenting users with the list of available device functionalities and providing a possibility to browse just the functionalities by simply clicking on them (see Figure 2 (1)). All the data processing that is required for the selected functionality is represented as a graph (see Figure 2 (2)) showing the connections between data categories. If there are any optional items in the graph, they are highlighted with the clickable dashed line in the graph path. After the selection, the dashed line becomes a solid one. If the data subject accepts the offered data processing for the functionality, the corresponding functionality is moved from the "Available Functionality" column to the "Accepted Functionality" column (see Figure 2 (3)).

From an understandability perspective, the participants of the usability testing positively evaluated the way the consent request was formulated. Since they liked the shortness, the plain language and the icons, we reused the consent text from the first version of the prototype. Every user action is, again, backed up by feedback. In the second prototype we added color-coding to the graph (see Figure 2 (4)), as it was suggested by many participants in the usability evaluation. A summary feature was also included in the simplified UI. The pop-up with a graph-based overview of the data processing, the users consented to, is always available under the "Summary" button.

In terms of revocation, CoRe UI provides the possibility to withdraw consent at any point in time by selecting functionalities in the "Accepted Functionality" column and clicking the "Revoke" button at the bottom of that column.

5.2 Results of the User Evaluations

The second CoRe UI prototype was evaluated by 73 participants. This time we targeted a broader segment of the population. 56% of the participants are male and 44% - female. They belong to different age groups (32% - 16 to 25 years old, 36% - 26 to 35 years old, 12% - 36 to 45 years old, 16% - 46 to 55 years old, and 4% - 55 years old and over). Almost half of the participants (44%) graduated from high school. Others have no degree with some college (17%), Master's (16%) or Bachelor's (15%) degree, and trade, technical or vocational training (6%). The background of 53% of the participants is education. Apart from education, the participants have a wide range of backgrounds: agriculture, environment and related studies (10%), engineering and related technologies (7%), information technology (7%), society and culture (7%), health (6%), management and

commerce (5%), architecture and building (3%), creative arts (1%), natural and physical sciences (1%). 63% of the participants come from Austria. Others come from Bulgaria, Germany, Hungary, Poland, Slovakia, Turkey, and the United States of America. The participants rated their Internet surfing skills as competent, proficient and expert. Most of them reported that they usually spend 3 - 6 hours (40%) or 1 - 3 hours (29%) on the Internet per day and preferably use a laptop (53%) or a desktop computer (26%) for the surfing.

In the second usability evaluation the users were given the same tasks as in the first usability testing, albeit slightly adapted to the updated prototype[13]. The same protocol was followed as in the first evaluation. The participants recorded their screen during the testing, and completed the same questionnaire. Our analysis of both the videos and the questionnaires is presented below.

Video recordings. In each of the 73 videos we observed that the UI was very easy to use. The participants made less mistakes than in the maximum control UI. We did not observe any confusion or misunderstanding of the UI. The users immediately noticed the clickable dashed parts in the graph. It took users, on average, only three minutes to complete all the tasks. For their own consent they needed approximately one minute. The videos showed that reducing customization complexity highly improved the performance of the users.

Comprehension testing. When describing what data processing the participants consented to, most of them (80%) provided correct information. This finding was further confirmed via open questions (e.g., "There were no problem understanding...", "... shows you exactly what you are consenting to").

Time perception. The way the users rated the time they spent on the tasks confirms what we observed in the videos. 38% of the participants were satisfied with the time it took them to complete the tasks and for 15% it took even less than they expected. 19% of the users think that it took them too long, but it was worthwhile. The rest (28%) still considered the process to be time consuming.

Adjective description. The users' interaction in the video left a very good impression about the prototype usability. Surprisingly, users still described the prototype as being "confusing" (40%), "annoying" (33%), "complex" (26%), "frustrating" (18%). From the video analysis and questionnaire answers we can infer that this was caused by the absence of bulk consent withdrawal functionality. Users were first confused and then irritated that they had to repeat the same action. On the other hand, for 15% of the participants the UI was "easy to use", 14% of the respondents considered the UI to be "flexible", 12% - "innovative", and 11% - "effective" and "friendly".

Prototype vs traditional consent request. The respondents named three main points why they liked the CoRe UI prototype better than traditional consent requests. The CoRe UI is: (i) more understandable (e.g., "It was very clear", "It is visual", "The consent request is not long, only few text and symbols for quick processing"), (ii) provides customization (e.g., "It's much better, because it is not just the text to read and then accept everything - you can decide what you accept"), and (iii) transparency (e.g., "I am more aware that my data are used

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[13] Usability evaluation tasks are available at: https://bit.ly/2KChPpF.

by so many applications", "It shows you exactly what you are consenting to"). We did not receive any negative feedback, however, 2 out of 73 participants wrote that they liked the traditional consent request because it is possible to consent to personal data processing using just a single button.

Ease of use. The easiest part for the users was to browse the available functionalities. Some of the participants mentioned that the prototype was in general easy to use after one became familiar with the UI (e.g., "The whole prototype is fairly easy, once one has familiarized himself with the options"). The hardest part was the fact that the prototype did not allow for the withdrawal of consent for multiple functionalities at once (e.g., "... I cannot revoke more functionalities at the same time"). This issue can easily be fixed by adding a feature where the users can select the functionalities in bulk.

Icons and color-coding. More than two thirds of the participants appreciated having icons in the graph. 23% of the respondents did not see the need in icons. The participants positively evaluated the color-coding as well. 82% found it useful and only 18% reported that they did not see any usefulness in it.

Summary graph. Most of the respondents to some extent (6% extremely, 11% very, 34% moderately, 26% slightly) understood the summary graph. 23% of the users did not understand the graph at all. 37% of the participants did not find the tree graph in the summary useful, 29% thought the graph was slightly useful, 22% selected "moderately useful" as their answer. Only a small percentage of the users 7% and 5% found the graph very and extremely useful respectively. The only issue the users mentioned regarding the summary graph was that the icons were too small (e.g., "Please put bigger icons").

Overall satisfaction. Although the CoRe UI prototype was very easy to use as evidenced in the video recordings, 39% of the participants still reported dissatisfaction with the prototype (18% - very, 21% - somewhat). 36% (31% - somewhat, 5% - very) of the users were satisfied and 25% were neither satisfied nor dissatisfied with the UI. 37% (26% - not so well, 11% - not at all well) of the participants reported that the way the consent request is presented does not meet their needs. The others were satisfied with the representation. Two thirds of the participants liked the UI prototype enough to want to recommend it to their friends. For 30% of the users it is not likely that they would do so.

Prototype improvement suggestions. A lot of the participants did not suggest any improvements. They pointed out that they understood the difficulty of the information visualization for the consent request, however, they did not know how the prototype could be improved (e.g., "I think it is pretty difficult to give a short overview of all the consent information covered on one page, therefore, I have no advice"). For others everything seemed to work well and the prototype did not need any adjustments (e.g., "No improvement necessary").

6   Conclusion

In this paper, we propose an innovative consent request user interface, which gives data subjects more control over the processing of their personal data.

During the research process we developed two CoRe UI prototypes based on the GDPR requirements and questions usually asked by lawyers when assessing the lawfulness of the personal data processing in the EU. The first prototype gave maximum control over personal data processing to the users, while the second prototype was simplified and provided less customization options. In both cases the consent request content was formulated as short phrases using plain language. The first UI was not well received by the participants of the usability evaluation. Users struggled with the evaluation tasks and as a result were not satisfied with the UI in general. The main issue for the users was too much control and complexity connected to it. Although the UI was perceived as complicated, the users liked the graphical visualization of the data processing as it made it easier for them to understand the implication of their consent. Additionally, the participants highly appreciated the customization feature, but they suggested to reduce its complexity.

Based on the insights gained from the first usability evaluation, we developed a simplified UI prototype. In this prototype the customization options were reduced to two actions: (i) browsing device's features and (ii) selecting third party data sharing options. All other information was just shown to the user in a graph form. In contrast with the previous evaluation, the users performed all tasks quickly, easily and almost without errors. The users liked the visualization and plain language and they appreciated the customization. The second round of testing indicated improvement in terms of performance and comprehension. However, in some cases, the users still complained about the amount of the information they had to digest.

All the materials used in the evaluations are available online, so that other consent UIs can be benchmarked against ours. Both evaluations showed that the users did not want to spend extra time on reading information in the consent request and suggested to simplify the customization feature. In order to address this issue the CoRe UI could be amended such that the functionalities or purposes for data processing are grouped into more general categories and allow consenting to a category but still retaining a more granular customization as well as detailed overview of the data processing available on demand.

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