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Raising Consent Awareness With Gamification and Knowledge Graphs:
An Automotive Use Case

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ABSTRACT

Consent is one of GDPR's lawful bases for data processing and specific requirements for it apply. Consent should be specific, unambiguous, and most of all informed. However, an informed consent request does not guarantee having individuals who are aware of what it means to consent and the implications that follow. Consent is often given blindly now, in particular because of information overload from long privacy policies written in legal language and complex interface designs that cause consent fatigue on the users' side. This paper presents a knowledge graph-based user interface for consent solicitation, which uses gamification to raise the legal awareness and ease individual's comprehension of consent. The knowledge graph models informed consent in a machine-readable format and provides a unified consent model to all entities involved in the data sharing process. The evaluation shows that with the help of gamification, the interface can raise individuals' average legal awareness to 92.86%.

KEYWORDS

Awareness, Gamification, Human-Computer Interaction, Incentives, Knowledge Graphs, Legal Comprehension, Semantics, User Interface

INTRODUCTION

Gathering information about one's behaviour is an important key to improving existing technology as it can provide an insight into behavioural trends (i.e., how and why individuals act in certain situations (Rodríguez et al. (2013), Štreimikienė (2014), Elbayoudi et al. (2016), Fotopoulou et al. (2017)). Such information has proven to be useful for large organisations in sectors such as insurance and online-advertising, who have started the trend of "behavioural targeting" (Jaworska and Sydow

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(2008); Zuiderveen Borgesius (2016)). Now, more than ever, personal data is being collected, analysed, and shared between multiple entities and, in most cases, the collection happens without one's consent and knowledge about the implications that follow (Joergensen (2014); Bechmann (2014)).

In order to change that, in 2018, the European Parliament and Council of the European Union[1] accepted the General Data Protection Regulation (GDPR)[2]. GDPR has led to a drastic change in how the personal data of European citizens is handled by introducing six lawful bases for the processing of personal data, one amongst which is consent. Consent has a crucial role since no data processing can begin without it. GDPR has set specific requirements for it (Art. 6, 7). Consent should be freely given, unambiguous, explicit, and most of all informed (Rec. 32). In order to have informed consent, a consent request, which is compliant with GDPR, must present information about what data is required, for what purposes, how the data will be processed, by whom, etc. (Art. 7, Rec. 32). However, presenting such information does not guarantee that one will be truly informed (i.e., aware of what it means to consent). There is a need for consent tools that focus on raising individuals' legal awareness while being compliant with GDPR (McStay (2013)).

One of the main means of requesting consent online is via a User Interface (UI) - a prompt window asking one to "Agree" to the presented privacy policy and terms and conditions, which are rarely read and *"when they are, they are hard to digest"* (McDonald and Cranor (2008); Drozd and Kirrane (2020)). The option to "Not Agree" is also rarely present (Utz et al. (2019); Matte et al. (2020)). Options such as consent revocation are, in many cases, hidden from individuals (i.e., one needs to search and go through several screens to withdraw the given consent). According to Article 7 of GDPR, *"it shall be as easy to withdraw as to give consent"* thus such consent request UIs are in violation. Giving consent by selecting "Agree" to the presented privacy policy does not imply that individuals are aware of what their actions mean and the implications that follow (Byrne et al 1988). For example, individual's vehicle sensor data such as fuel and speed can be used by insurance companies to make decisions about the value of the vehicle and for medical payments or personal injury protection coverage in the case of a car accident. Such data could be used to adjust a driver's insurance premiums upwards or downwards depending on their driving habits, age, and health without the driver realising that this adjustment was based on continuously collected data. In most cases, one gives consent without questioning what is asked and for what purposes (Bechmann (2014); Joergensen (2014)). Bechmann (2014) defines this behaviour as a beginning of a culture of "blind consent". Humans look for visual cues when presented with content (Clark and Mayer (2016); Brookhaven National Laboratory (2017)). Presenting individuals with long paragraphs of legal text does not ease comprehension (Wszalek (2017); Ericsson (1988); Kurteva and de Ribaupierre (2021)). Instead, it can lead to confusion and information overload (Gross (1965)), which can make one dismiss the process by giving consent without being informed.

When it comes to the comprehension of consent, a common understanding of what it means to consent needs to be established within the system itself, which also involves human interaction. For example, in large organisations, implementing informed consent is done collaboratively by individuals from different domains (e.g., legal, technology, business). Once shared between humans, the knowledge needs to be translated to a machine as well. Semantic technology, namely ontologies and knowledge graphs (KGs), are able to represent various domains by modelling domain-specific concepts and the relationships that hold between them (Uschold and Grüninger (1996); Guarino et al. (2009)). In complex scenarios, such as data processing in compliance with GDPR, KGs provide a common ground of terms and their meaning in both machine-readable and machine-understandable formats (Taye (2010)). With the help of relationships, KGs support data interoperability, traceability and transparency, which GDPR stands for. An advantage of using semantics for consent is the ease with which an existing semantic model can be expanded and adopted to other laws, domains and use cases, where consent plays a role. Due to their flexibility and expressivity, semantic technology can help capture and describe in detail the dynamic nature of consent based on different contexts. Numerous ontologies for consent have been built through the years and their use and benefits are

evident as presented in the survey by Kurteva et al. (2021). In this work, authors also present a review of existing consent visualisation tools, their advantages and disadvantages and is used as inspiration for the solution presented in this paper. While a semantic model of consent supports the machine's comprehension of consent, it is not as easy to do so for individuals with no experience in Semantic Web technologies. The challenge of providing individuals with means to execute their consent rights (give and revoke consent) in an easily comprehensible manner, while being compliant with GDPR, remains.

The CampaNeo project, which this work is part of, aims to develop an open platform for secure and GDPR compliant vehicle sensor data collection with the help of semantically modelled campaigns (i.e., an informed consent request for specific data sharing). Once consent is received, sensor data can be collected, analysed and sent to research institutions, insurance companies, etc. As increased data-sharing may seem negative at first, on a larger scale for humanity it can benefit medical or technological advancements, which would not be possible with too few datasets (Herrera et al. (2021)). The results can help improve one's driving experience and safety on the roads with real-time accurate traffic notifications. However, as individuals have different reasons to share data, ways to both encourage campaign participation and raise consent awareness are needed.

Based on this use case, this article presents a GDPR compliant consent solicitation tool with a User Interface, which focuses on raising individual's awareness of consent and the implications that follow with the help of gamification (Deterding et al. (2011a); Deterding et al. (2011b); Seaborn and Fels (2015)). The UI follows the CampaNeo ontology[3], which models GDPR knowledge about consent and displays the minimum amount of information needed for informed consent (see Art. 7, Rec. 32). Further, it adopts incentives, specifically from gamification (Deterding et al. (2011a); Deterding et al. (2011b)) to overcome bias and motivate campaign participation, thereby increasing data-sharing engagement. However, the implemented gamification is optional. It is used as a tool to raise campaign engagement and consent awareness. Consent can be given and revoked freely at any time.

The main research questions that this paper aims to answer are:

- "Does a graphical visualisation of an informed consent request help raise one's awareness?"
- "Do gamification incentives affect one's willingness to consent?"

This rest of the article is organised as follows. The related work section provides an overview of existing solutions for informed consent visualisation, comprehension and for gamification. The methodology presents the followed research methods. The approach and implementation section describes the UI's implementation and the CampaNeo semantic model. The evaluation set up and the evaluation results are presented next. Finally, a conclusion and future work are discussed.

RELATED WORK

This section presents related work in the fields of informed consent visualisation (based on GDPR) and gamification for behavioural change. By comparing existing regulations and consent practices adopted by social media platforms such as Facebook[4], Bechmann (2014) found that the need for convenience has created "a blind informed consent culture" (i.e., privacy policies are not read and consent is directly provided). However, the survey by Bechmann (2014) also showed that individuals who have been victims of personal data misconduct were more concerned about their privacy and personal data sharing. A similar survey by Joergensen (2014) confirmed that users are unaware of their privacy rights and what happens to their data. Both Bechmann (2014) and Joergensen (2014) showed that individuals had a general knowledge of what types of information should and should not be shared online but they lack knowledge regarding data sharing on a company level and the related privacy risks.

Angulo et al. (2015) propose the Data Track tool, which aims to raise individuals' awareness of data sharing with the help of a visualisation of all of the information that has been shared for different services. By selecting a specific service or service provider on the UI by Angulo et al. (2015), a panel with information about the specific data that is shared is displayed to the user. The evaluation showed that a visualisation of personal data sharing helped enhance transparency. However, the presence of too many icons on the UI and at random places resulted in confusion and prolonged response time of individuals.

Drozd and Kirrane look further into the topic of raising legal awareness and presented the consent request (CoRe) UI (Drozd and Kirrane (2019)) and its third iteration the Consent reqUest useR intErface (CURE) UI (Drozd and Kirrane (2020)). With the help of features such as customization and drill-down visualisations, the CURE UI achieves higher transparency concerning personal data processing. To avoid the all-or-nothing approach, which is used by existing consent requests (see Nouwens et al. 2020; Utz et al. 2019), the CURE UI allows users to decide between maximum privacy with minimum device utility by using a slider bar (the bottom of the slider indicated minimum privacy). Further, the CURE UI allows consent revocation by sliding the pointer up in order to withdraw multiple purposes at once or manually (i.e., one can deselect individual purpose by deselecting the corresponding checkbox). The evaluation of Drozd and Kirrane (2020) showed that visualisations can support transparency and comprehension. However, it also showed that the issue of information overload persists - users are overwhelmed when given too many options and information all at once. With all the different kinds of online services provided to users, it becomes harder and if not impossible for individuals to keep track of their personal data sharing.

Bless et al. (2021) raised the awareness for data sharing by 76.5% with the help of a KG-based web application that visualises real-time personal data sharing flows from vehicles (e.g., GPS, speed) based on given consent. The tool follows CampaNeo's KG but in comparison to the UI presented in this paper, it focuses on what happens once consent is given (i.e., consent requests are not visualised). The two-step evaluation of the user's comprehension of consent (before and after using the tool) showed that users' knowledge of what it means to consent was improved. After using the visualisation tool, 85.5% of the participants responded that they would share driving behaviour information if they have access to such tool. Bless et al.'s (2021) work shows that visualisations of data sharing flows enhance transparency, increase users' willingness to share more data and raise awareness about what it means to consent.

Marwick and Hargittai (2019) conclude that 'trust' is the key factor that affects one's choice. Users are more likely to share personal and general data if they trust the website or the purchase provider. However, establishing trust could take a long time, which is a drawback for many companies. Vassileva (2012) presents a review of existing approaches, based on theories and research in behavioural economics such as Lee et al. (2011), Carrascosa et al. (2015), Staiano et al. (2014), and in social psychology such as Fiske et al. (2010), Hodgetts et al. (2020), which motivate users to participate in social computing applications. In order to change one's behaviour "one needs to create an appropriate system of incentives (rewards)" (Vassileva 2012). An example is the gamification mechanism adopted by Comtella (Bretzke and Vassileva (2003)), in which users are rewarded with points once they complete a specific task. The results of the evaluation of this mechanism showed a significant but short-term increase of participation. Theories such as Theory of Cognitive Dissonance (Festinger (1957)) show that people compare themselves with others thus a good and successful incentive should introduce the notion of competition between the users (Vassileva (2012)). The rewards need to be visualised as well so that the user sees what they have actually achieved. In Bretzke and Vassileva (2003) for example, one status is visualised as a star on the night sky. The higher the status, the bigger and brighter the star was. Such point-based gamification systems and leaderboards are also used in Cheong et al. (2013), Eickhoff et al. (2012) and Farzan et al. (2008). Examples of different types of gamification mechanism and their success in domains such as education, health and wellness, orientation etc. are presented in more detail by Seaborn and Fels (2015).

Filippou et al (2013), Hamari et al. (2014) and show that gamification can have positive effects on one's behaviour and learning. For example, incentives have been adopted by number of learning platforms such as Codecademy[5] and Badgeville[6] . Marwick and Hargittai (2019) show that in most cases people are willing to share data with institutions if there is a personal gain such as better service personalisation, financial and health benefits. Incentivisation is also used in other domains, such as energy efficiency. Examples include the work of Böckle and Yeboah-Antwi (2019) and the Entropy project[7], which aims to establish an energy-aware IT ecosystem by monitoring users' behavioural changes. In Entropy, upon a task's completion a user receives a reward in the form of a voucher. The project showed that with recommended personalised actions, a positive change in the users' behaviour occurs.

Table 1 summarises the existing work and provides a comparison with the writers' solution. The table presents the main goal of each study, if consent can be given and revoked, if consent is informed, use of semantics, special features for each study and current limitations. Additionally, Table 1 shows that not much related work that aims for transparency in data sharing and comprehensive consent management uses semantic technology, and that tools for GDPR compliant data sharing are also needed for several different device platforms.

In conclusion, consent visualisation has been a topic of interest for many. The visualisation of consent request with graphs has shown to support comprehension and to build trust in individuals (Drozd and Kirrane (2019), Drozd and Kirrane (2020), Bless et al. (2021)). However, challenges such as information overload due to the presence of complex privacy policies, displaying too many visual elements and confusion due to the complexity of the visualisation itself are still present. Further, bias (caused by external or internal factors) still plays a role in one's willingness to consent. To solve these challenges, this paper presents a cross-platform application that aims to raise one's legal awareness of consent and GDPR with the help of gamification. The followed methodology, the implementation and the evaluation results are presented in the next sections.

METHODOLOGY

The methodology for this research is based on Irby et al. (1977), follows Nielsen's Engineering Model (Nielsen (1992)) and laws of User Experience (UX) (Yablonski (2020)). The first step comprised of reviewing the CampaNeo use case and existing solutions for consent based on GDPR. Further, the CampaNeo ontology was reviewed and extended with relevant concepts. Following the use case, target user groups (vehicle owners and drivers) and the tasks that can be performed by them on the UI (e.g., giving and revoking consent) were derived. The implementation of the UI consisted of two phases. Phase one focused on designing informed consent request forms (i.e., the campaigns) and on implementing the functionality for giving and revoking consent. Phase two focused on the gamification and on improving the overall UI design. The final step included the evaluation of the UI with users and its comparison to existing tools. The main technologies used for this work are the Flutter[8] toolkit for cross-platform UI development and GraphQL[9], which uses the CampaNeo KG[10] for consent as its schema. SPARQL was used to define sample KG queries. Details about the design decisions and the implementation are presented in the next section.

APPROACH AND IMPLEMENTATION

This section presents the approach and the implementation details of the proposed CampaNeo cross-platform application for consent solicitation. The application, which has been motivated by an automotive case, utilises the CampaNeo KG as a schema and allows individuals to exercise their GDPR rights. First, to create their GDPR compliant semantic model for CampaNeo, the authors combined existing ontologies and extended them to the vehicle data-sharing use case by modeling car sensors and the concept of a campaign, through which data requests can be performed. Furthermore, for the

Table 1. The related work table comparing the author's contributions to the work done by others

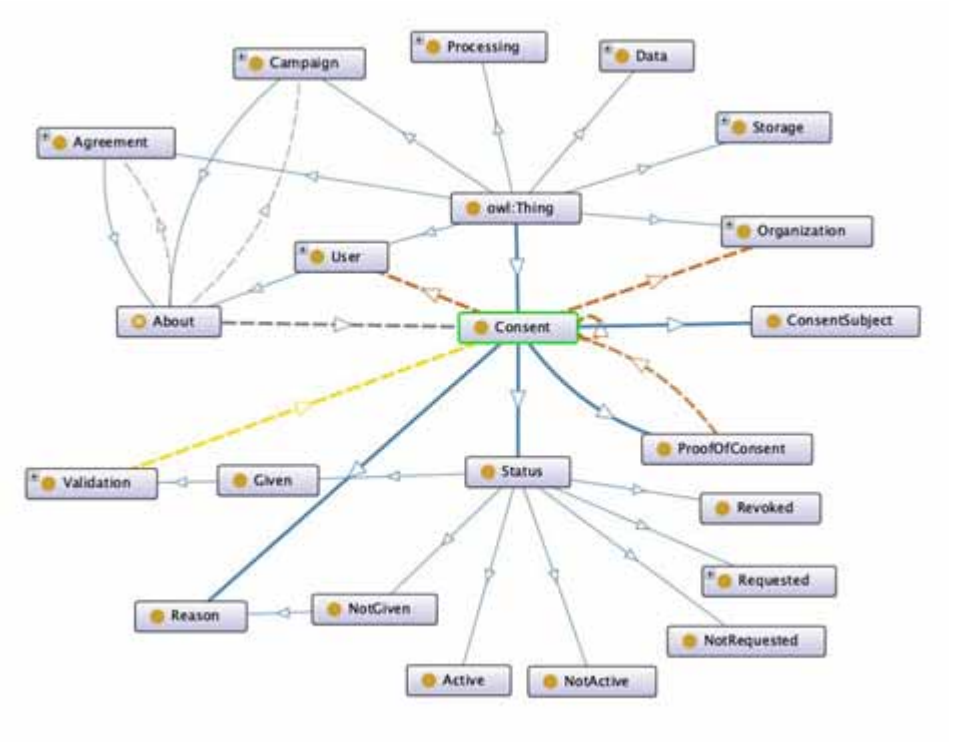
Study	Main goal	Can users give consent?	Can users revoke consent?	Does the tool follow GDPR's requirements for informed consent?	Use of semantics?	Special feature	Limitations
Data Track tool by Angulo et al. (2015)	Enhance transparency regarding data disclosed to online services.	No	No	No	No	Trace view visualisation of user disclosed data.	The tool was built before the acceptance of GDPR. Data sharing preferences (i.e. consent) can be modified only if a service allows it. Consent revocation has not been discussed.
CoRe UI by Drozd and Kirrane (2019)	Give users more control of their data sharing and improve their comprehension of consent.	Yes	Yes	Yes	No	A "drill-down" visualisation of consent information based on specific processes.	67% of the users found the UI prototype "complex" and the whole process "time consuming". 55% defined the consent representation as "confusing".
CURE UI by Drozd and Kirrane (2020)	Bring transparency regarding personal data processing and improve the comprehension of consent.	Yes	Yes	Yes	No	Visualisation of consent requests based on a purpose with graphs.	Built for laptops and desktops.
Visualisation tool by Bless et al. (2021)	Raising awareness about consent by visualising what happens to individual's data after consent is given.	No	No	Yes. Only data sharing based on informed consent can be visualised.	Yes. The tool is based on the CampaNeo ontology and KG.	Visualisation of data sharing flows.	Consent management features have not been implemented.
This work	Raise the awareness and ease the comprehension of consent with the help of gamification.	Yes	Yes	Yes	Yes. The tool used the CampaNeo ontology and KG.	Consent request in the form of campaigns. Gamification and incentives.	The UI only supports laptop or tablets to mimic the dashboard of a car. User cannot manage their consent before entering their car. Additionally, not all user archetypes are satisfied with the current gamification elements.

UI development, the authors based their design decisions on UX laws such that each element in the UI is as intuitive as possible, leading to users performing conscious actions when giving or revoking consent. Lastly, the authors apply two gamification elements, a point-based system, and a leaderboard, to raise data-sharing engagement. Users are rewarded more when sharing more data, and they can compare themselves to other users as a competitive incentive, while also gaining insight as to how many campaigns other users consented to.

The CampaNeo Semantic Model

The CampaNeo KG (Figure 1) is the main semantic model for representing informed consent as defined by GDPR in the CampaNeo project. By reusing concepts such as *gconsent:Consent, gconsent:Status, gconsent:DataRetrieval, gconsent:DataRestriction* etc. from GConsent[11], *sosa:Sensor, sosa:hasSimpleResult* from Sensor, Observation, Sample, and Actuator (SOSA) (Janowicz et al. (2019)) and modeling sensor data such as *CampaNeo:GPS*, *CampaNeo:hasGPSlatitude, CampaNe*

Figure 1. The CampoNeo ontology



o:hasGPSLongitude,CampaNeo:Campaign, CampaNeo:Purpose, the KG is able to model informed consent in the form of campaigns. Organisations from different domains (e.g., automobile, agriculture, government, education), which can have the role of a campaign creator and user specific information such as *CampaNeo:hasEmail, CampaNeo:hasMobilePhoneNumber* needed for compliance are modelled as well. The KG is used as a schema for a Graph API through which campaigns are received from external CampaNeo components.

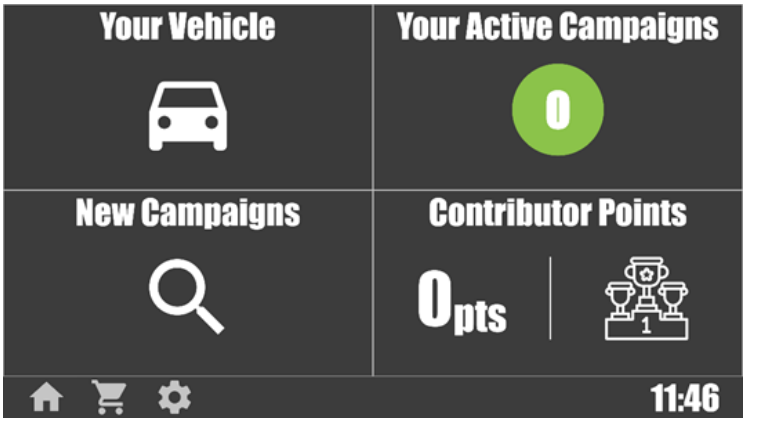
Design

This work focuses on CampaNeo's main use case - requesting and receiving consent for vehicle sensor data sharing in a vehicle. Since displays in vehicles are often compact, small and at arm-length distance, the CampaNeo UI reuses well known navigation gestures and design patterns in order to ease and minimise user interactions.

The UI (Figure 1) is inspired by the CoRe and CURE UIs (Drozd and Kirrane (2019), Drozd and Kirrane (2020), follows psychology findings and UX laws such as *Hick's law*[12], *Fitts's law*[13], and *Jakob's law*[14]. According to these laws, the application should only show relevant information, minimising the possible choices and actions to increase simplicity, have buttons easily reachable in terms of positioning and size, and have similar behaviour as other applications making it easier for users to perform actions. For example, the UI follows Jakob's law of familiarity (users can tap outside of a dialog box to remove it).

The home screen (Figure 2) comprises of a four-tile menu, which users can use navigate through the UI. The UI enables users to consent to or decline campaigns, specify data sharing preferences (i.e. which sensors to share), collect and exchange points for vouchers, view accepted campaigns and active data sharing and most importantly - revoke consent. Further, users can see how high they rank

Figure 2. The CampaNeo UI main screen, which consists of four tiles aimed at easing the navigation through the application



based on their collected points via a scoreboard. Figure 3a presents a scrollable list of all campaigns (accepted, declined or pending). To establish consistency, each campaign is displayed in a tile and follows the CampaNeo KG data model and GDPR requirements for informed consent. A campaign description has a purpose, specific data the consent is about, duration, contact information of the campaign creator and presents users with the right to consent or not. By presenting users with the minimum information needed for consent the UI aims to increasing their reading attention as suggested in Ebert et al. 2021. By following Gestalt's law of similarity[15], the UI conveys the message that all tiles are clickable and fulfill a purpose. Upon selecting to participate in campaigns, users can select what sensor data they wish to share (Figure 4a). Specific data is associated with specific number of points (Figure 4a). By selecting the "i" icon users can receive additional information about the requested data. Notice that users are only presented with the information they wish to see (inspired by the *Hick's law),* which prevents information overloaded and eases interactions.

Gamification

The main goal of the adopted gamification is to increase user engagement and participation in campaigns via the CampaNeo UI. According to Tondello et al (2016), users' motivation to participate can be classified as *intrinsic* or *extrinsic*. Intrinsic motivation is the direct and personal beneficial effect or reward of a task from a user's point of view, while extrinsic motivation defines the expected outcome when completing an action. A challenge when using gamification to increase engagement

Figure 3a. Campaign listing screen

Figure 3b. A campaign's details representing an informed consent request

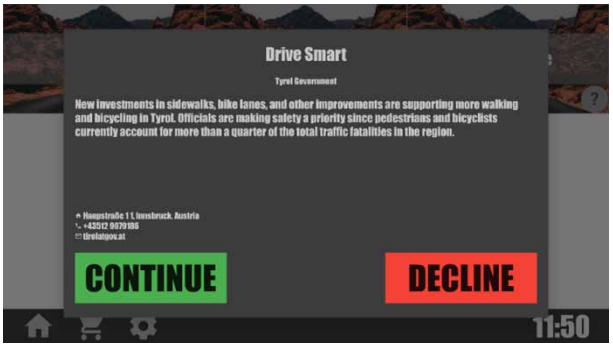


Figure 4a. Users can select the data they wish to share

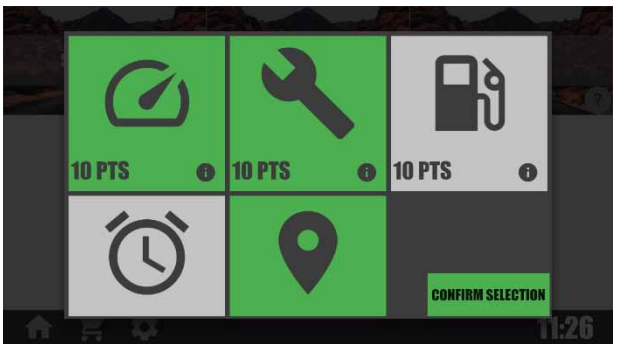
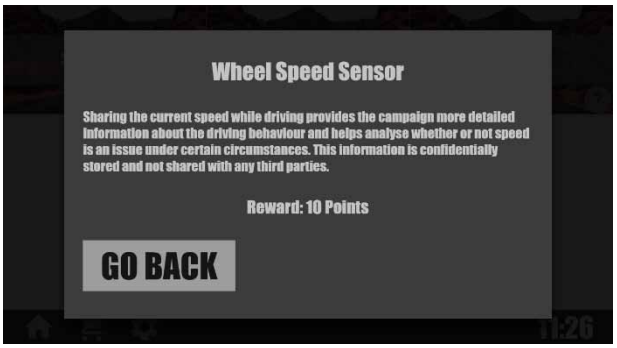


Figure 4b. Users can view specific details about the data



is implementing the correct game design elements, which target different user archetypes (e.g. philanthropist, socialiser, achiever, player (Tondello et al. (2016))). According to Marczewski (2015), an application should have certain features if one wants to target such users.

Figure 4 shows a detailed overview of the specific data for which consent is requested.

The CampaNeo UI adopts a simple, yet effective gamification mechanism based on the work of Vassileva (2012), which rewards campaign participation with points that can later be exchanged for coupons (or vouchers). For example, a one-time coupon for 30% reduced fuel price. The more

data users share the more points they can collect. To further encourage participation in campaigns, the UI provides a leaderboard, which ranks users based on their campaign participation (Figure 5b). These incentives satisfy the requirements for the *player, socialiser* and *philanthropist archetypes*. The *player* is presented with a point-based system and a leaderboard. Where the latter also motivates the *Socialiser* by creating a social interaction between users within the application, in this work it comes in the form of competitive comparison. *Philanthropists* are, in most cases, the easiest type of archetypes to target as they tend to participate without expecting anything in return.

Figure 5 shows two incentives.

All of the source code can be found at https://github.com/STIInnsbruck/Campaneo-UI including a demonstration video[16].

EVALUATION PROCESS

The UI was deployed on a Github pages website[17] as a web application, which allowed it to be used on both laptops and tablets. For the evaluation, sample campaigns, which represented real-world data sharing requests were provided by CampaNeo's industry collaborators. Initially, a face-to-face in-vehicle evaluation was planned. However, due to the state of the pandemic, the evaluation was

Figure 5a. Listed coupon, which users can purchase with their collected points

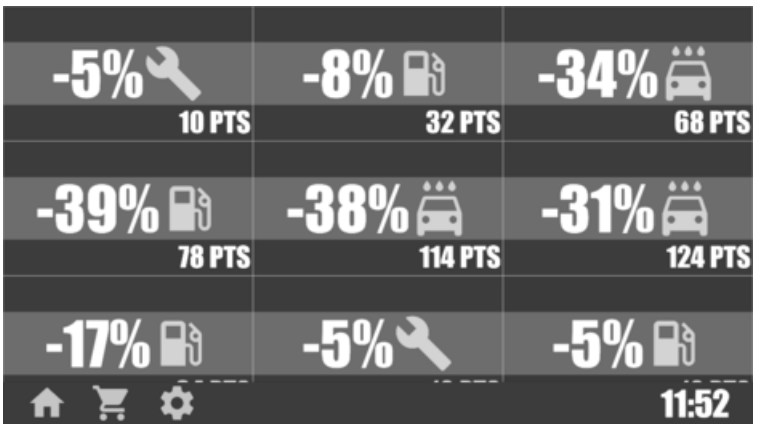


Figure 5b. A scoreboard that displays current campaign ranking of all users

performed online via communication channels such as Zoom and Skype. The average duration of the evaluation was 25 minutes. The participants (21 in total) were asked to share their screen so that the authors can evaluate the usability of the UI in real-time. The participants (computer science students, researchers, and non-computer science experts) were recruited via the university network and private channels.

The evaluation consisted of six steps. During step 1 the participants were introduced to GDPR, consent, and the notion of campaigns and were asked to generate a random hash, which was used for anonymisation purposes. Step 2 consisted of a demographics survey in which information such as age, gender, driving experience, internet surfing experience was collected. In step 3 the participants were presented with a real-life scenario involving the CampaNeo UI. Based on this, during step 4, the participants were asked to complete several tasks (e.g., to give, revoke consent) to evaluate the usability of the UI. Further, during this step, the Think-Aloud[18] method was used (i.e., participants were asked to speak their mind when completing the tasks). A comprehension survey, which focused on evaluating participants' understanding of GDPR and campaigns (after using the UI) was conducted during step 5. Finally, the participants were asked to complete a UI survey (step 6), which helped evaluate the UI's design and participants' satisfaction with it.

In addition, to understand how the CampaNeo UI performs in comparison to existing solutions such as the one by Drozd and Kirrane (2020), part of the survey questions and tasks that were presented to users were inspired by the evaluation of the CURE UI (Drozd and Kirrane (2020)). Table 2 presents the usability tasks used for the CURE UI and their corresponding equivalent, which was used for the evaluation of the CampaNeo UI. The results of performing these tasks are presented in the evaluation results section.

Figure 6. The evaluation process used for every participant

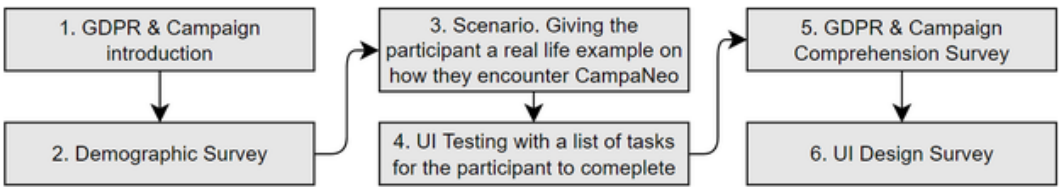


Table 2. Comparison of the usability tasks from Drozd and Kirrane (2020) and the tasks of CampaNeo

Task	Text of the Task (CURE)	Task	Text of the Task (CampaNeo)
T1	Have a look at the detailed overview of the required data processing for the functionality "display route on map".	T1	View a new campaign.
T2	Give your consent to process your information to have health data on your device.	T2	View details about the new campaign.
T3	Give your consent to enable the fitness adviser.	T3	Select what data will be shared.
T4	Give your consent to turn on the back-up for you data.	T4	Give consent.
T5	Withdraw your consent to derive your cardio fitness score.	T5	Revoke consent for a campaign of choice.

EVALUATION RESULTS

This section presents the results from all three surveys for each participant, including the overall completion rate for each task given to the users in step 4 of the evaluation process. In the Comparison to the CURE UI subsection, the authors' solution is compared to the inspired work by Drozd and Kirrane (2020). In subsection Understanding GDPR, the authors analyse whether the notions of GDPR are clear to the participants, followed by the last subsection describing how the researchers' solution was perceived by the users. The evaluation question and results from the three surveys were exported from Google Forms and converted into csv files[19]. Based on the unique hashes, the surveys were combined for each participant and analysis was performed in LibreOffice Calc. 21 participants (47.6% male, 47.6% female and 4.8% prefer not to say) from different age groups, ranging from 18 to over 50 (23.8% from 18 to 22, 23.8% from 23 to 26, 19% from 27 to 30, 9.5% from 31 to 34, 4.8% from 43 to 46, 9.5% from 47 to50 and 9.5% above 50), took part in the evaluation. 66.7% of them own a car, 33.3% use their car every day or two to three times per week. The analysis of the completed tasks (Figure 7) on the UI showed that 10 out of 13 tasks were completed successfully by all participants. The tasks that were not completed by all of the users are "view rejected campaign", "exchange reward points" and "view incentives". With an 85.71% success rate, the task to view the incentives was most challenging. This can be due to participants being unaware of what the terms incentives mean due to coming from different cultural and educational backgrounds.

Another observation is that some participants found it hard to navigate to the shop page to exchange their points. This can be used as feedback for improving the navigation of the UI.

The results of the comprehension survey (Figures 8a and 8b) showed that after using the application 95.2% of the participants understood (71.4% agreed and 23.8% strongly agreed) what giving consent means. 85.7% of the participants felt more confident in their GDPR knowledge after using the UI. These results show that a graphical visualisation of informed consent can help raise participants' awareness.

Regarding increasing the willingness to consent with gamification incentives, Figure 9a shows that all participants found the incentives attractive and tempting (66.7% agreed and 33.3% strongly agreed). Further, Figure 9b shows that the majority of the participants feel more motivated to participate in a

Figure 7. CampaNeo UI usability evaluation tasks. A task is considered successful if it is completed without any guidance or hints.

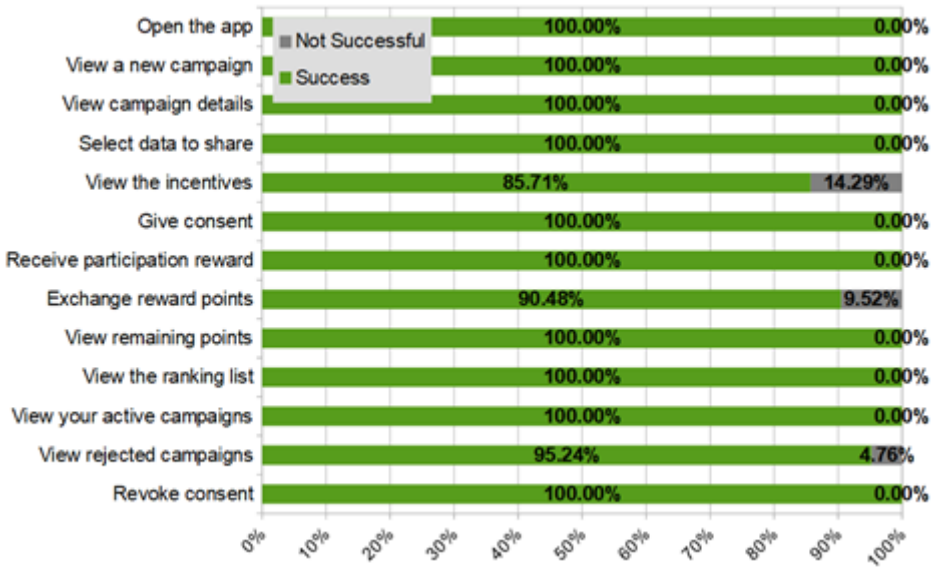


Figure 8a. Evaluation of the users' consent comprehension

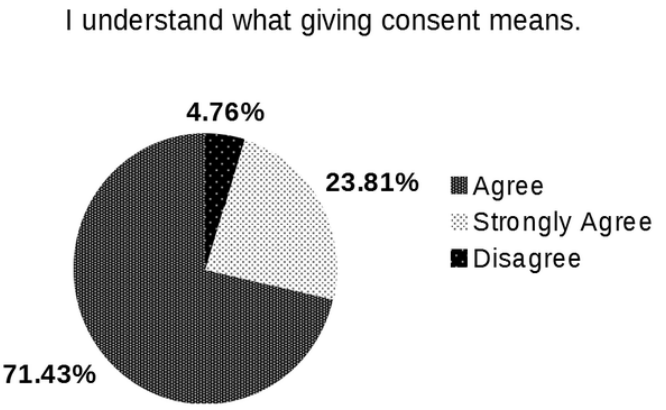
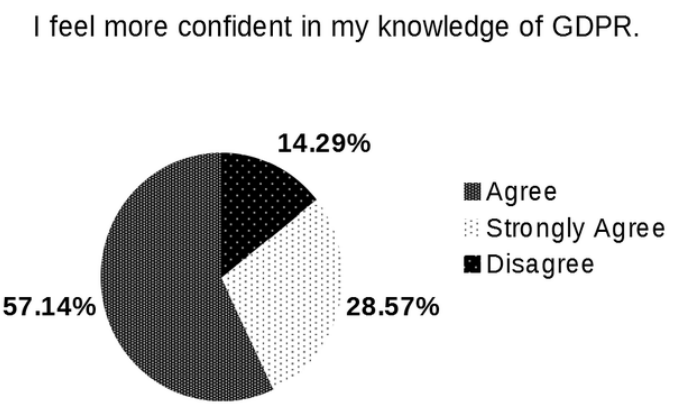


Figure 8b. Their confidence in knowledge of GDPR



campaign (or to share data) when incentives are present. This leads to the conclusion that incentives play an important role when it comes to consent.

Comparison to the CURE UI

The evaluation by Drozd and Kirrane (2020) showed that the CURE UI is "easy to use" as all tasks were completed with an average time of 1 second. During the evaluation of the CampaNeo UI, the task completion time was not considered as the UI itself offers more complex features such as the gamification, which required users to navigate through several screens. Figure 7 presents a complete list of all 13 tasks, which were given to users to complete and their success rate. The analysis showed that all 13 tasks were successfully completed with an average success rate of 97.8%. In comparison to tasks such as consent revocation (100% success rate), others related to the adopted gamification approach scored less (85%-90.48%). This can be due to having users from different demographic

Figure 9a. The overall satisfaction with incentives

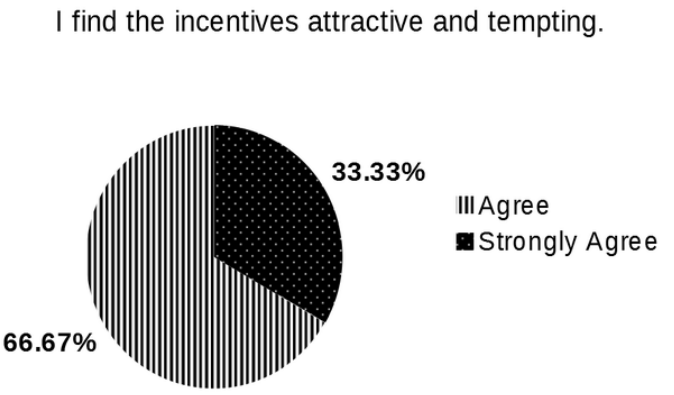
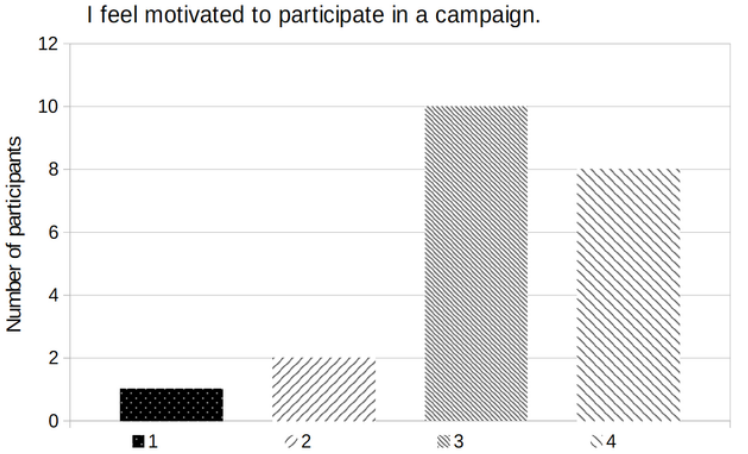


Figure 9b. The motivation to participate in campaigns (1 – the most disagreeable, 4 – the most agreeable)



backgrounds and who might not be familiar with terms such as incentives and gamification. However, in addition to being able to successfully complete the same tasks (as on the CURE UI), the users of the CampaNeo UI were also able to successfully interact with the gamification feature.

Understanding GDPR

During the comprehension survey all participants were asked detailed questions about their understanding of GDPR, their consent rights and whether companies were allowed to share their personal data without their consent. The analysis showed that 100% of the participants know they can give consent, 85.7% knew that they can withdraw consent, 76.2% know they do not have to give consent. Further, 81% know that they can restrict data sharing and can erase their consent. However, only 57.1% know that they can access data that is being shared. Keeping in mind the limited number of participants in all age groups, the best performing groups are 23-26, 43-46 and, 50+ years old with

an average answer correctness greater than 92.86%. The worst performing age group is 27-30 with a correctness of 60.71%. The correctness is calculated by how many correct answers were selected compared to the amount of actual correct answers.

When asked "*What do you think happens after consent is given*", 76.2% answered that only the companies that have their consent can use their data, 61.9% said from that point onwards data sharing begins. For "*What do you think happens after consent is withdrawn*", 81% of the participants were aware that data sharing stops and that companies are not allowed to use the data anymore. When asked to state the entity (or company) that requested consent and its purpose, 81% were able to provide a correct answer, 19% were not able to. "*Can one company share your data with another company without your consent?*" was answered correctly ("No") by 81% of participants. For "*Can you name all entities that are involved in the data sharing process according to your given consent?*", 38.1% answered "No". 28.6% were able to name only a few entities, while 33.3% answered "Yes".

Finally, 95.2% knew that data sharing stops when consent is withdrawn. 47.6% stated that data sharing stops when a campaign, to which they consented, ends. 4.8% stated either that the data sharing does not stop after a campaign ends or that they do not know when it ends.

Feedback for Improvement

This section presents the analysis of the design survey:

- **Look and feel:** 95.2% stated that the characters are easy to read, 100% agreed that the colour pallet is appropriate, and 95.2% that the elements of the UI are well organised.
- **Giving Consent:** 100% of the participants state that giving consent is easy (61.9% of strongly agreed). Regarding the ease of consent revocation, 42.9% strongly agree that it was easy, 57.1% agreed, which shows a slight increase in the complexity of consent revocation.
- **Motivation:** 85.7% of participants said they are motivated to engage in campaigns (Figure 9b). 66.6% indicated that they feel inclined to recommend CampaNeo to others (19% strongly agreed and 47.6% agreed), 28.6% were neutral and 4.8% disagreed and strongly disagreed.
- **Incentives:** The gamification elements targeted 53% of all users as mentioned in the implementation section, yet all 100% of the survey answers show that the participants found the incentives attractive and tempting (33.3% strongly agreeing and 66.7% agreeing) (Figure 9a).
- **Adjectives:** The participants were asked to select one or multiple words to describe the UI (Figure 10). With the first five adjectives being negative and the other five positive, one can see a positive result for the application's design and usability. However, 19% of the participants selected "Time-consuming", which means that limitations are present and need to be addressed in the future in order to speed-up the time it takes to give consent.
- **Portability:** Initially, the UI was developed only for vehicle infotainment systems. When asked if they could imagine using the application on a mobile device or a tablet, 95.2% of the participants agreed to using it on their mobile device and 71.4% agree to using it on a tablet. This shows that in the future, the CampaNeo UI can be adopted to other platforms to reduce the amount of time spent in the car (individuals can give consent prior to driving).
- **User Friendliness:** In the demographic survey, the participants were asked about their internet surfing skills and average time spent on the internet on a daily basis. This helped understand the usability of the UI with regards to both experienced and non-experienced internet users. The answers from all participants were compared. No correlation between one's internet surfing experience and comprehension was found thus the UI can be seen as user friendly to all user types.
- **Further Findings:** As predicted, by creating competition, the CampaNeo UI's scoreboard raised the interest in many users to share even more data. However, not all users realised that the more data they share the more points they would receive. Many users were unaware of how to navigate back to previous pages due to the limited number of icons for that. The participants also gave their

opinion on how to improve the UI. The main ideas were to "*add more back buttons*", "*design is a bit `flat`, maybe add some more colour*", "*organise the rewards in the shop*", "*display my points in the shop*" and to "*clarify that the points are spendable for rewards*".

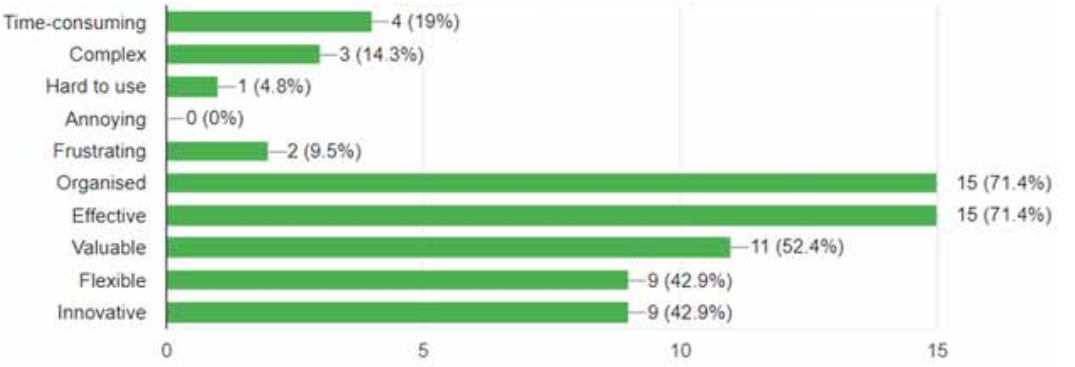
CONCLUSION

This paper presented the CampaNeo UI for consent solicitation, which by using graphical visualisation of consent request and incentives helps raise individuals' legal awareness. With the help of a KG, which models informed consent as defined by GDPR and provides a unified model for consent for all entities, the UI complies with GDPR's requirements for requesting consent as presented in Art. 4(11) and Art. 7. Further, the CampaNeo ontology and KG add increased transparency, tracking and can help enforce GDPR compliance by requiring consent requests to be conform to the ontology. In order to use the CampaNeo UI when requesting consent from individuals, companies need to follow the underlying semantic model. This ensures that each consent request, which is presented on the CampaNeo UI is GDPR compliant. In addition, the UI enables individuals to exercise GDPR rights such as giving and revoking consent (another GDPR requirement according to Art. 17). The evaluation of the UI showed that with the help of gamification, the CampaNeo UI helps raise both the awareness and willingness of individuals to consent. This work's evaluation process was also inspired by the work of Drozd and Kirrane (2020), allowing the results to be comparable to theirs, successfully showing that there is room for improvement, as more features can be built in, such as, gamification and semantic technology, to improve human-computer interaction and data-sharing awareness. The applied gamification elements proved to be effective as all participants stated that they find them attractive and tempting to engage in campaigns and share more data, resulting in an increased willingness to consent. The authors believe that such application can be useful for consent in other domains such as health, smart cities and agriculture where data sharing is key. Although the evaluation did not take place as initially planned due to current covid regulations, it showed that the developed solution for consent can be used as a standalone application on different devices and different environments with ease.

However, the evaluation has also highlighted some challenges such as the UI's navigation and the participant's interaction with the gamification. Currently, the gamification targets only specific archetypes, which can be seen as a limitation. Further, the current version of the UI has been built for laptop and tablet screens. Small screen devices such as smartphones were not considered, which could help improve consent management by consenting or revoking consent before entering a car.

Future work will focus on improving the UI overcoming these limitations. Features such as user registration and the users' ability to pre-select types of consent request they wish to receive based on,

Figure 10. Design survey feedback. Adjectives describing the UI and their selection rate in percentage.



for example, specific consent purposes or sensor data can be implemented as well. A possible direction is to explore which other gamification strategies can be successful when it comes to consent. Finally, a planned activity is to build a mobile application, based on the current design of the CampaNeo UI to ease the process of consent solicitation on smartphones.

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ENDNOTES

1 https://europa.eu/european-union/index_en
2 https://data.europa.eu/eli/reg/2016/679/oj
3 https://github.com/STIInnsbruck/CampaNeoViz/blob/main/CampaNeoOntology_rdfxml.owl
4 https://www.facebook.com
5 https://www.codecademy.com
7 http://www.thegamifiers.com/partners/badgeville/
[7] https://entropy-project.eu
8 https://flutter.dev
9 https://graphql.org
10 https://graphdb.sti2.at/hierarchy
11 https://openscience.adaptcentre.ie/ontologies/GConsent/docs/ontology
12 https://lawsofux.com/hicks-law/
13 https://lawsofux.com/fittss-law/
14 https://lawsofux.com/jakobs-law/
15 https://lawsofux.com/law-of-similarity/
16 https://www.youtube.com/watch?v=m_aHF7l0nDI
17 https://stiinnsbruck.github.io/Campaneo-UI/build/web/index.html#/
18 https://www.nngroup.com/articles/thinking-aloud-the-1-usability-tool/
19 https://github.com/STIInnsbruck/Campaneo-UI/tree/pages/evaluation/results

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