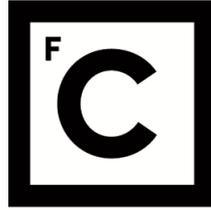UNIVERSIDADE DE LISBOA
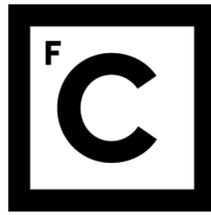FACULDADE DE CIÊNCIAS

Democratizing User Interfaces

"Documento Definitivo"

Doutoramento em Informática

Sérgio Flávio Barros Antunes Alves

Tese orientada por:
Prof. Doutor Tiago Guerreiro, Prof. Doutor Kyle Montague

Documento especialmente elaborado para a obtenção do grau de doutor

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To my Parents.

Abstract

User interfaces (UIs) are key intermediaries for accessing public services, information, and entertainment. Nevertheless, most UIs follow a *one-size-fits-all* approach, which limits their experience in contexts or by users not considered during design. UI personalization seeks to bridge this gap by aligning standardized layouts with individual preferences, enhancing efficiency, usability, and accessibility. While some systems allow superficial adaptations (e.g., color modes and font sizes), these are often misaligned with users' actual needs and preferences. Conversely, more open-ended approaches (e.g., code injection) demand significant effort and expertise, placing them beyond the reach of most users.

This dissertation investigates the democratization of UIs, which results from empowering users to meaningfully reimagine and redesign the interfaces they use in daily life. Democratization extends beyond simply providing personalization options; it requires creating conditions where all users (not only experts) can exercise agency over their interfaces. This involves reducing the effort required for implementation and supporting users in identifying personalization opportunities that are both significant and beneficial.

To address this challenge, we placed users at the center of our research. Across four studies, participants were invited to share their perspectives, supported in identifying and enacting interface changes, and encouraged to reflect on how personalization tools and UIs should be designed. Specifically, we examined how community-based mechanisms can support personalization implementation and how access to interaction data can facilitate ideation.

This work makes several contributions, including: (1) an in-depth account of user needs, practices, and challenges in personalization; (2) the concept of *community-based personalization* as a way to adapt, share, and reuse interface customizations; (3) design considerations for leveraging interaction data to guide users toward meaningful personalization; and (4) a design space for end-user UI personalization to inform future research and practice.

Keywords: Personalization, Human-Computer Interaction, Graphical User Interfaces, Customization, Democratization

Resumo

Uma interface gráfica pode ser definida como o "*meio através do qual um utilizador interage com um sistema operativo ou com um programa*"[1]. Estas interfaces são cada vez mais relevantes. Os serviços digitais têm-se tornado cruciais, muito devido à proliferação de *smartphones*, computadores e outros dispositivos que facilitam o acesso à Internet. As interfaces destes serviços constituem, assim, intermediários fundamentais para o acesso à informação, comunicação, entretenimento e até a serviços públicos, como saúde ou finanças.

Alguns destes serviços (por exemplo, plataformas de comunicação) são utilizados por centenas de milhões de pessoas, resultando numa base de utilizadores extremamente diversa. Esta heterogeneidade inclui diferenças nas capacidades físicas e cognitivas, níveis de literacia digital e preferências pessoais. Para além disso, o contexto de uso pode variar em cada interação, originando o fenómeno descrito como deficiências e incapacidades induzidas situacionalmente (*situationally-induced impairments and disabilities*, em inglês). Por exemplo, um utilizador pode temporariamente obter visão turva após um procedimento ocular ou enfrentar menor precisão ao interagir com um ecrã tátil enquanto caminha. É, portanto, fundamental garantir que todos os utilizadores conseguem não só aceder, mas também usufruir de uma experiência de utilização adequada às suas necessidades e preferências.

Muitas das interfaces existentes foram desenhadas segundo uma lógica *one-size-fits-all* (tamanho único para todos, em português), procurando assegurar que são utilizáveis pela maioria. Isto deve-se ao facto de serem concebidas para utilizadores e cenários de uso típicos, ainda que exista hoje maior preocupação e obrigação em garantir acessibilidade, e por vezes alguns utilizadores sejam envolvidos no processo de design. Contudo, a maioria dos componentes destas interfaces permanece estática e inadaptável, dificultando o uso em situações ou por utilizadores não contemplados no desenho inicial. Além disso, abordagens como *universal design* ou *design for all*, que ambicionam garantir que qualquer interface possa ser utilizada por qualquer pessoa, são frequentemente consideradas utópicas.

Endereçar esta diversidade e garantir experiências de utilização mais equitativas requer que as interfaces possam ser personalizadas em função de cada utilizador. Uma

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[1]https://dicionario.priberam.org/interface

experiência totalmente personalizada implica não só receber "*o conteúdo certo, no formato certo e no momento certo*", mas também permitir que os utilizadores definam o que "certo" significa de acordo com as suas necessidades e capacidades. Abordagens que incluem mecanismos de personalização por defeito, como interfaces adaptativas, adaptáveis ou inteligentes, falham precisamente em oferecer liberdade suficiente aos utilizadores para ajustarem as interfaces de forma aberta às suas preferências. Isto deve-se também ao facto de continuarem a limitar os utilizadores às opções antecipadas como úteis pelos designers.

Nesta dissertação, focámo-nos na forma como o conteúdo é entregue, isto é, na camada visual e interativa através da qual os utilizadores acedem à informação. Explorámos a personalização de interfaces como estratégia para democratizar o design de interfaces gráficas, tradicionalmente fora do controlo dos utilizadores. Por democratizar entende-se empoderar qualquer utilizador a exercer, direta ou indiretamente, controlo sobre as interfaces que utiliza.

A personalização de interfaces pode ter múltiplos benefícios: expressar identidade, reforçar a sensação de controlo e agência, aumentar a satisfação ou melhorar a acessibilidade. Contudo, as funcionalidades atualmente disponíveis não empoderam suficientemente os utilizadores, sobretudo os não especialistas. Por um lado, as opções de personalização incluídas por defeito nas interfaces existentes são muito limitadas (por exemplo, ajuste de cores e tamanho de fonte). Por outro, ferramentas externas que oferecem maior liberdade, como a possibilidade de injetar código, exigem demasiado tempo, necessidade de clareza sobre o que se pretende personalizar e conhecimentos técnicos que a maioria não possui.

Assim, democratizar interfaces não significa apenas disponibilizar opções de personalização, mas também apoiar os utilizadores neste processo. Isto envolve facilitar a implementação (para especialistas e não especialistas) e apoiar a identificação de oportunidades de personalização que sejam realmente significativas e benéficas.

Esta dissertação tem como objetivo estudar como empoderar os utilizadores, para que consigam, de forma significativa e simples, reimaginar e redesenhar as interfaces com que interagem no dia-a-dia. Colocamos os utilizadores no centro da investigação, promovendo uma série de estudos em que foram escutados, apoiados na identificação e personalização de elementos das interfaces que utilizam e estimulados a refletir sobre como as ferramentas de personalização e as interfaces em geral devem ser desenhadas para melhor responder às suas necessidades.

Em resumo, esta dissertação responde a três perguntas de investigação: (1) qual é a visão das pessoas sobre exercer controlo democrático sobre as interfaces que utilizam e como imaginam que mecanismos de personalização podem apoiar esse processo; (2) que uso fazem dos mecanismos de personalização existentes e quais são as suas necessidades e preferências; e (3) como garantir que a personalização é acessível, promovendo

simultaneamente liberdade, independência e uma tomada de decisão informada.

A dissertação desenvolveu-se em quatro etapas:

Primeira etapa: Na primeira fase desta dissertação executámos dois estudos complementares. Primeiro, focados em perceber de que forma os utilizadores planeiam personalizar as suas interfaces, realizámos um estudo onde sete participantes (1) registaram num diário (durante duas semanas) as alterações que desejam fazer nas interfaces que utilizam regularmente, (2) personalizaram essas interfaces de forma livre, e (3) participaram num grupo de foco para discutir o futuro da personalização e criação de interfaces. Os resultados deste estudo demonstraram que personalizar interfaces e refletir sobre como fazê-lo de forma significativa é um "exercício" pouco habitual, com várias dificuldades. Os participantes demonstraram preferência por personalizar menus e páginas iniciais, com o principal objetivo de aumentar eficiência. Estes tipos de mudanças requerem mover, reordenar, esconder e adicionar novos elementos a interfaces, o que são opções tipicamente não suportadas pelas interfaces *mainstream*. No geral, os participantes demonstraram também desconhecimento das ferramentas de personalização existentes, preocupações com privacidade, mas grande interesse em ter "*todo o controlo a que tenham direito*".

De seguida, realizámos um questionário online com 145 participantes. O objetivo era perceber como as necessidades capturadas no primeiro estudo refletem as perspetivas mais gerais da população, como as pessoas utilizam os mecanismos de personalização existentes, e as suas perceções sobre os fatores relevantes para a adoção destes mecanismos. Os resultados indicam que as pessoas utilizam muitos dos mecanismos de personalização atualmente fornecidos por defeito (por exemplo, cores e fundos) e também que muitas delas (mais de 40%) procuram soluções externas, mas poucas atualmente as utilizam (cerca de 10%). No geral ficou também claro que existe uma grande diversidade de preferências que não pode ser atendida apenas com opções pré-definidas.

Segunda etapa: Tendo em conta os resultados da primeira etapa, explorámos depois uma abordagem de personalização suportada pela comunidade. Num estudo com nove participantes, investigámos de que forma as pessoas requerem ajuda a personalizar a outros membros da comunidade e, por outro lado, ajudam esses membros. No geral, os participantes demonstraram bastante interesse em apoiar a comunidade, mas sentiram dificuldades em identificar personalizações úteis para si próprios. Daqui surgiu o conceito de *community-based personalization*, em que personalizações podem ser publicadas, partilhadas e reutilizadas por diferentes utilizadores.

Terceira etapa: Focámo-nos precisamente no problema da identificação de oportunidades de personalização. Realizámos um estudo de entrevistas semiestruturadas com 12 participantes, utilizando cenários experimentais para obter a perspetiva dos participantes sobre como eles poderiam beneficiar de aceder a dados de interação para encontrar e considerar possibilidades de personalização. Os resultados mostraram que as pessoas valorizam e conseguem utilizar dados de interação para identificar melhorias, mas preferem

suporte durante o processo. Querem sistemas que sugiram alterações, mas que a decisão final e liberdade de implementação permaneçam com eles.

Quarta etapa: Para tornar as contribuições mais aplicáveis, concluímos com a proposta de um espaço de desenho: *the design space of end-user user interface personalization*. Este espaço representa características e valores que as pessoas valorizam na personalização e o seu objetivo é que seja utilizado para orientar o desenvolvimento de ferramentas mais alinhadas com as preferências dos utilizadores.

Em resumo, e sempre com o foco na perspetiva dos utilizadores, esta dissertação oferece seis contribuições:

1. Estudo aprofundado das necessidades e preferências de personalização.

2. Levantamento das práticas existentes de personalização.

3. Identificação dos fatores que influenciam a adoção de mecanismos de personalização.

4. Análise da dinâmica de assistência à personalização e apresentação do conceito inovador de personalização baseada na comunidade.

5. Considerações de desenho para integrar dados de interação em ferramentas de personalização.

6. Proposta de um espaço de desenho (*design space*) sobre personalização de interfaces pelo utilizador final.

Palavras-chave: Personalização, Interação Pessoa-Máquina, Interface Gráfica do Utilizador, Customização, Democratização

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Chapter 1

Introduction

As society becomes increasingly digitized, user interfaces (UIs) have become essential intermediaries for communication, services, or entertainment (Ruth et al., 2022), making it crucial that everyone can effectively interact with them. The proliferation of smartphones, computers, and other digital devices has expanded the potential user base for graphical interfaces to billions worldwide (Pelchen and Allen, 2024), creating a vast and diverse user population (Ruth et al., 2022). This population varies significantly in ability, digital literacy, or personal preferences, making the user base exceptionally heterogeneous (Wobbrock et al., 2011).

Users' unique characteristics can influence how they engage with UIs, with different individuals experiencing the same UI in entirely different ways (Oh and Sundar, 2016; Lavie and Meyer, 2010; Sundar and Marathe, 2010). Yet, many UI components remain standardized and rigid, often overlooking individuals who fall outside the assumptions of a "typical" user, such as those at the margins of tech proficiency. This exclusion can limit digital participation and reinforce inequities. More fundamentally, many users have little or no influence over the design of the interfaces they depend on, remaining subject to choices made by or for others.

Addressing users' diversity and enhancing their satisfaction requires moving beyond one-size-fits-all interfaces (Hussain et al., 2018) toward designs that can be personalized according to individual characteristics (Paternò, 2013) or usage context (Wobbrock et al., 2011). Ultimately, a complete personalized experience can be understood not only as receiving "*the right content in the right format at the right time*" (Ho and Tam, 2005), but as citizens having the agency to define what "right" means for their own needs and contexts. Building on this perspective, this dissertation focuses on the delivery of content (the visual and interactive layout through which users receive and engage with information), exploring UI personalization as a strategy for democratizing users' control over the design of traditionally standardized graphical user interfaces.

1.1   Motivation

A graphical user interface is "*the way in which the information on a computer, phone,
etc. and instructions on how to use it are arranged on the screen and shown to the user*"
(Cambridge, 2023). UIs represent a set of design examples unparalleled in human history
and serve as the primary gateway for accessing and navigating the digital world.

Most UI development techniques place the design burden on UI experts: designers or
developers (Stone et al., 2005). Traditionally, these professionals control the UI crafting
process entirely, devising designs, defining interface components, collecting and assess-
ing interaction data at will, or running experiments. While there are design paradigms
that seek to consult and include end-users within the design process, such as through par-
ticipatory or co-design activities (Hansen et al., 2020), these efforts typically engage only
a small subset of users, leaving many potential barriers unaddressed for the broader popu-
lation. Ultimately, despite these efforts, designers and companies retain decision-making
authority over the final product. As a result, UIs are frequently crafted to provide the best
user experience to the broadest possible group of people, often following a one-size-fits-
all approach targeting the "average" user (Saati et al., 2005).

To address diverse user needs, design paradigms, such as universal design (Mace et al.,
1990), inclusive design (Clarkson, 2004; Keates et al., 2000), or design for all (Stephani-
dis, 1997), aim to design consumer products that are accessible to the majority of the
population. They achieve this by explicitly designing for the needs and capabilities of dif-
ferent users. However, these approaches have been labeled utopian, given the challenge
of meeting all needs through a single interface (Newell and Gregor, 2000; Trewin, 2000).

In today's digital landscape, UIs remain a source of exclusion (Msweli and Mawela,
2020). One-size-fits-all design approaches fail to account for the diversity of users and
their contexts, resulting in unpleasant experiences or accessibility barriers (Hussain et al.,
2018; Power et al., 2012). This diversity results from individuals' varying abilities, needs,
goals, and characteristics, as well as the different circumstances and devices through
which they access UIs (Iqbal et al., 2021; Wobbrock et al., 2011; Wobbrock, 2019; Kong
et al., 2025; Borgman, 1992). Moreover, people prioritize different types of information
and prefer to explore, interpret, and manipulate it in distinct ways (Karger and Quan,
2004; Brandenburger and Janneck, 2024). In essence, today's UIs remain insufficiently
adapted to accommodate this diversity, and if users want to take action and adapt UIs,
they are left with minimal or no control.

Systems based on the principles of intelligent UIs (Sullivan and Tyler, 1991; Stephani-
dis et al., 1997; Tajja et al., 2024), context-aware computing (Barkhuus and Dey, 2003),
adaptive and adaptable software (Kühme, 1993; Findlater and McGrenere, 2008; Stuer-
zlinger et al., 2006; Findlater and McGrenere, 2004), or automatically generated UIs
(Gajos et al., 2010) typically incorporate built-in mechanisms that support UI personaliza-
tion according to individuals' abilities or context. For example, a system might automat-

ically enlarge text for low-vision users or rearrange menu items based on usage patterns (Gajos and Weld, 2004). However, these solutions might not always align perfectly with the multitude of users' preferences or the dynamics of human behavior, as designers cannot anticipate every real-world use case, leaving users constrained by pre-defined options (Stuerzlinger et al., 2006; Coutaz, 2010).

Simultaneously, the digital world has progressively shifted toward greater citizen involvement in shaping and using technology. From Web 2.0 and user-generated content (Paternò, 2013) to the democratization of access to information through the Internet, social media, smartphones, and even 3D printing (Stein, 2017), people have increasingly sought to play active, creative roles in the digital world. Conversely, although tools such as web augmentation software (Rashid et al., 2006) have enabled some degree of control over UIs, most individuals still lack meaningful control over the UIs they interact with. This gap underscores an opportunity to evolve digital spaces to better account for individuals' uniqueness (Borgman, 1992), beginning with granting users greater agency and decision-making power in shaping their everyday digital environments.

Addressing this gap aligns with broader calls to ensure that users retain agency, transparency, and control over digital systems (Floridi et al., 2018; Cremer et al., 2021; EU, 2024), highlighting the need for better alignment of technologies with human-centric values, limitations, and societal norms (Valdez et al., 2024).

This dissertation advances the democratization of UIs by investigating how end-users can be empowered to actively shape their digital environments. Specifically, it explores how individuals can be supported to freely repair, optimize, and personalize UIs at runtime and across contexts.

UI personalization generally takes two forms: user-driven, where individuals directly modify layouts using third-party customization tools (Nebeling et al., 2013) or built-in adaptable features (e.g., font adjustments); and system-driven, where UIs automatically adapt based on behavior or context through adaptation software (Wu et al., 2022; Gaspar-Figueiredo et al., 2025a) or adaptive UIs (Liu et al., 2024).

Our goal is to move personalization beyond restrictive, pre-defined options, toward more unrestricted and transformative, user-driven possibilities, enabling individuals to exercise agency over interface design in ways that reflect their needs, preferences, and contexts. This perspective builds on the concept of *system appropriation* (Dix, 2007), highlighting how people creatively extend, repurpose, or adapt technology in ways not initially anticipated by designers.

In this context, UI customization software plays a central role. Such tools empower individuals to take direct control of the personalization process (Sundar and Marathe, 2010; Sundar, 2008; Marathe and Sundar, 2011; Jameson, 2007), enabling manual manipulation of properties of visual elements like buttons or text. The outcomes may include a visually adapted menu, a personalized data feed, or a new color scheme (Nebeling et al., 2013;

Kumar et al., 2011).

People benefit from personalization regardless of their abilities, age, or expertise. Customized UIs can enable access to initially inaccessible areas of the screen (Wu et al., 2022), improve user experience (Nebeling et al., 2013), efficiency (Reinecke and Bernstein, 2011), overall satisfaction (Proença et al., 2021; Gajos et al., 2010; Benlian, 2015; Liu et al., 2024), or website stickiness (Benlian, 2015). Simultaneously, customization yields psychological benefits by enhancing the sense of control (Marathe and Sundar, 2011), identity (Häkkilä and Chatfield, 2006; Oulasvirta and Blom, 2007), or personal agency (Sundar, 2008).

However, previous customization work has a limited presence in current UIs. By default, when users open a web page or application, they encounter minimal options (e.g., color modes) to adjust the UI to their abilities and preferences. These pre-defined built-in customization operations are often restrictive, providing little support for more transformative and desired personalization operations, such as rearranging interface elements (Nebeling et al., 2013). Moreover, there is a false perception about the level and types of personalization introduced into software, a phenomenon known as the *Personalization Myopia* (Oinas-Kukkonen, 2018; Oinas-Kukkonen et al., 2022), in which users believe they have access to more personalized features than they have, and experts mistaken regarding the level of personalization they introduce into software. Alternatively, third-party personalization solutions are of users' interest (Biniok, 2022; SimilarWeb, 2022b; Nebeling et al., 2013; The Browser Company, 2024) but have not yet been completely incorporated into their digital routines.

At the same time, supporting unanticipated and unrestricted personalization, where users personalize UIs in ways not foreseen by software creators, introduces two crucial challenges that this dissertation addresses explicitly. First, this level of control can require technical expertise (e.g., coding skills) and significant physical and cognitive effort, making the execution of personalization inaccessible to many (Mackay, 1991; Park and Han, 2011). Second, for personalization to be democratic, it is important that individuals can make informed and independent personalization decisions. When relying solely on assumptions or subjective impressions, users may misjudge personalization opportunities, overlooking inefficiencies or overestimating the use of certain features, which ultimately can limit their ability to personalize in ways that truly serve their needs.

Promising yet underexplored directions for addressing these challenges include leveraging the power of open communities, where users collaborate independently from designers (as seen in accessibility research (Takagi et al., 2008)), and providing users with access to their own interaction data (e.g., click activity), which can enable them to make informed decisions based on actual usage patterns rather than perceptions. Through unrestricted personalization, decision-making support, and participation in these communities, end-users can signal that they are not passive recipients but active agents in shaping inter-

faces, finding spaces to express their needs, collaborate with others, and shape interfaces to address personal and shared goals.

1.2 Research Goals

We have the ultimate goal of democratizing end-users' control over the UIs they use. In this dissertation, we investigated how to achieve UI democratization through UI personalization. Drawing from democratic principles, rooted in freedom and equality where power is distributed and individuals participate in decision-making, we advocate a shift from static, developer-controlled interfaces toward a more democratized process, where individuals can exercise agency over the design of the UIs they use. We propose to do this shifting in a way that ensures users' independence from designers and developers, enabling them not only to repair but also to reshape and reinvent UIs according to their values, interests, and circumstances.

This research followed a user-centered approach. Consequently, the questions we formulated evolved throughout the doctoral program. We addressed the following research questions (RQs):

(**RQ1**) *How do people envision exercising democratic control over the interfaces they interact with, and how do they see personalization mechanisms supporting this process?*

(**RQ2**) *What use do people make of existing user interface personalization features, and what are their personalization needs and preferences?*

(**RQ3**) *How can we support users in taking greater control over the personalization process, in accessible ways that advance UI democratization by promoting personalization freedom, human independence, and informed decision-making?*

1.3 Research Approach

This section presents the research approach to answer our RQs, providing an overview of the methods and results that informed each subsequent research stage. Although our research comprises four user studies, we present them across three stages, with the first stage combining two complementary studies. Throughout our work, we mainly used web UIs to develop and demonstrate practical personalization examples but explored personalization opportunities for a broader range of devices and interface types, including mobile devices and desktop applications.

1. **A User-Centric Exploration of User Interface Personalization Needs, Practices, and Aspirations**. The first two stages of our research focused on studying people's perspectives regarding personalization and their digital experience. We investigated personalization from a UI democratization perspective, including understanding whether people wish for more control over their UIs, how they expect to utilize that control (i.e., personalization preferences) and how they currently do it (i.e., current personalization practices), and how they envision the possibility of increasing their agency over UIs. We performed two complementary user studies to obtain this knowledge and identify relevant features for the development of future personalization software:

   1.1 First, we performed a co-creation study, where seven participants (1) created a diary of their desired personalizations, (2) customized their UIs freely with a researcher's support, and (3) discussed their digital experiences in a focus group. We sought an **in-depth understanding of UI personalization needs, preferences, and aspirations**.

   1.2 Through a second study, an online survey, we collected a **larger-scale understanding of personalization practices and perspectives**. This enabled us to understand the gap between current personalization offerings and people's preferences, as well as their visions for different forms of personalization.

2. **A Community-Based Approach Aimed at Democratizing Personalization**. Results from the first stage of our research highlighted the value of more controllable forms of personalization, like UI customization. However, customization solutions (Biniok, 2022; SimilarWeb, 2022b) often require technical skills, time, and effort beyond the reach of most users (Mackay, 1991; Park and Han, 2011). The third stage focused on studying how to **make UI customization accessible** to non-expert users, with the aim of enabling equal access to personalized digital environments. To that end, we explored the concept of community-based personalization, where users can, for the first time, customize UIs for themselves and others through a customization assistance request process. We developed a custom browser extension, *GitUI*, which enables users to customize existing web pages and to make and respond to customization assistance requests. To explore its use and dynamics in practice, we conducted an exploratory two-week study with nine participants (both experts and non-experts). Based on insights from this study, we proposed the concept of community-based UI personalization, in which users can personalize interfaces for themselves, request assistance from others, or install and refine publicly available templates.

3. **Reflections on the Role of Interaction Data in Empowering User Decision-Making for UI Personalization**. People enjoyed the concept of community-based

personalization but identified the need for support in identifying personalization opportunities and ideating forms of personalizing UIs (i.e., alternative designs). Simultaneously, previous work highlighted the need for creating opportunities for users to reflect on their interactions with UIs (Mackay, 1991) and support them in assessing personalization benefits and value (Banovic et al., 2012).

In this stage of the doctoral program, we investigated a reflexive approach to UI personalization, where users engage with their own interaction data (such as click activity, scroll depth, and time spent on interfaces) to identify and reflect on personalization opportunities. We conducted an interview study with 12 participants, employing experimental vignettes as design probes to explore how people respond to different forms of engaging with interaction data to support UI personalization. These forms varied in the degree of system support provided for understanding and acting (i.e., personalizing) on the data, including features such as data explanations (with text-based personalization suggestions) and assisted implementation (with visual personalization suggestions that users could accept). Our findings show a preference for an assisted user-driven personalization setup, in which people can reflect and retain control over personalization decisions and outcomes, but the system leads the design and implementation process.

4. **The Design Space of End-user User Interface Personalization**. To conclude, we consolidated the key concepts that emerged across our four studies into a design space that captures the categories and qualities end users value and expect from personalization software. The design space comprises seven categories that describe: the extent and malleability of personalization (how unrestrictively users can personalize and reuse those changes); the magnitude and legibility of personalization changes (how deeply users can transform interfaces and how are they supported in understanding the changes); and the level of decision support and data agency (how assisted user personalization is and how much control they have over the data that informs it).

1.4 Research Audience

The knowledge produced by this research can benefit a variety of stakeholders involved in interface design. Although our work mainly focuses on user-driven personalization, our findings are relevant to user- and system-driven approaches, encompassing built-in (e.g., adaptive and adaptable software) and external repair solutions (e.g., customization and adaptation software). We anticipate the following stakeholders will gain valuable insights from the work presented in this document:

- **HCI, SE, AI, and Accessibility Research Communities**. Our work informs re-

searchers from multiple research domains. The primary beneficiaries are researchers in *Human-Computer Interaction* (HCI), *Software Engineering* (SE), and *Artificial Intelligence* (AI), but we also contribute with knowledge to *Accessibility* research. Researchers from these domains can get insights into how end-users interact with personalization features, the factors impacting personalization adoption and use, or how to manage factors like *controllability*, *transparency*, *effort*, or *privacy* in both user- and system-driven solutions. Our work also explores the intersection of UI personalization and responsible AI (Dignum, 2019), contributing to ongoing discussions about how systems can provide valuable, transparent explanations to users while maintaining autonomy in decision-making processes.

- **User Interface Designers and Developers**. Our research is relevant to both general UI designers and developers of specific personalization technologies. For UI designers, we offer a deeper understanding of how personalization can enhance user satisfaction, efficiency, or accessibility. This dissertation is also a call for attention for these professionals to include more personalization options by default in their software. We also contribute with design strategies and user needs relevant to support the transition to more adaptable or adaptive UIs. For developers of personalization software (such as customization tools, adaptive systems, or accessibility solutions), we offer an understanding of how people engage with existing personalization solutions, and, above all, we highlight personalization needs that are unfulfilled by existing software.

- **Users**. We expect to impact how end-users perceive and engage with their digital environments. As we noticed with our study participants, discussions about UI personalization and democratization can change individuals' perceptions of their existing level of agency towards UIs and how UIs are structured. Anyone can benefit from personalization, and our research did not target a specific user group. To extend the impact beyond the studies, we made *GitUI* publicly available[1], ensuring end-users can use one of the outputs of this dissertation. The tool was developed iteratively and carefully refined following our final study, with updates focused on enabling interaction data collection and visualization.

1.5   Contributions

This section details the main contributions of this dissertation.

1.5.1   Scientific and Theoretical Contributions

The primary scientific and theoretical contributions of this dissertation are the following:

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[1]https://chromewebstore.google.com/detail/gitui-web-customization-t/bpmijdlmnbbiijodjakioajbjnfgflph

(C1) **An in-depth study of personalization needs and preferences.** Our research presents the first exploration of personalization needs and perspectives of users of traditional UIs in a setup where they had complete personalization freedom. Unlike previous work focused on specific tools or pre-defined personalization options, our methodology enabled users to articulate and envision their personalization preferences freely. The resulting insights contribute not only to an understanding of people's needs but also to an understanding of the challenges they encounter in an unrestricted personalization environment (e.g., ideation challenges).

(C2) **A detailed account of existing personalization practices.** Based on the results of an online survey with 145 participants, we provide the first analysis of the current personalization practices of users of traditional UIs.

(C3) **A collection of the factors impacting UI personalization adoption and its impact across the existing personalization approaches.** We updated information regarding the factors impacting UI personalization adoption and provided an analysis of how the impact of these factors varies across typical personalization approaches.

(C4) **An analysis of the dynamics of a personalization assistance apparatus and the community-based personalization concept.** We provide (1) the first in-depth analysis of the dynamics of a personalization assistance system involving human support, (2) the design and users' feedback of a working prototype demonstrating the feasibility of end-user UI customization for the self and others, and (3) a conceptual contribution of a novel community-based UI personalization concept.

(C5) **Design considerations for integrating interaction data with UI personalization.** We contribute design considerations to inform future solutions that leverage interaction data to support user-driven personalization. Specifically, we provide strategies for integrating interaction data into software that (1) help users identify personalization opportunities, (2) streamline the design and implementation process, (3) highlight both the perceived and practical benefits (such as increased efficiency and usability), and (4) empower individuals to confidently take control of their UIs, ultimately fostering adoption and long-term engagement.

(C6) **A design space of end-user user interface personalization.** The design space offers opportunities to enhance communication between developers of personalization software and end-users, while also supporting developers in mapping their systems to users' perspectives.

1.5.2   Artifacts Contributions

We published the materials we used to conduct our user studies in online repositories. We outline two resources that can be particularly useful for future research:

- *GitUI - Web Customization Tool.* We published a personalization tool that enables users to customize their UIs and visualize interaction data relevant to personalization (e.g., click activity). This beta version[2] contains many of the features we describe in this document and tested with participants.

- **Interaction data vignettes.** The vignettes used in our last user study to elicit people's opinions on using interaction data to support UI personalization are available online[3]. These vignettes offer a resource for researchers that can be adapted and reused for conducting similar vignette-based experiments.

1.6   Publications

As part of this doctoral program, we have authored and co-authored several publications. The following highlight our contributions related to UI personalization and democratization:

- *Sérgio Alves, Ricardo Costa, Kyle Montague, Tiago Guerreiro. "GitUI: A Community-Based Platform to Democratize User Interfaces"* (CHI EA '23). In this late-breaking work (Alves et al., 2023), we propose and discuss the concept of community-based personalization for the first time (Section 4.4).

- *Sérgio Alves, Ricardo Costa, Kyle Montague, Tiago Guerreiro. "Citizen-Led Personalization of User Interfaces: Investigating How People Customize Interfaces for Themselves and Others"* (CSCW 24). This paper (Alves et al., 2024) presents the results of our study on the dynamics of UI customization, focusing on how people customize interfaces for themselves and others (Chapter 4).

- *Sérgio Alves, Kyle Montague, Tiago Guerreiro. "Personalization in Practice: Investigating Current Practices, Challenges and Aspirations"* (UNDER REVIEW). In this paper, we present the outcomes from the first two stages of this dissertation (Chapter 3).

- *Sérgio Alves, Carlos Duarte, Kyle Montague, Tiago Guerreiro. "Exploring the Role of Interaction Data to Empower End-User Decision-Making In UI Personalization"* (UNDER REVIEW). In this paper, we report the findings from Chapter 5, together

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[2]https://chromewebstore.google.com/detail/gitui-web-customization-t/bpmijdlmnbbiijodjakioajbjnfgflph
[3]https://osf.io/8awdj/?view_only=9451ed14653b4a96857750ff9eeb9b3b

with design considerations for integrating interaction data into a UI personalization apparatus.

Simultaneously, our work on UI personalization also resulted in a master thesis:

- *Ricardo Costa. "GitUI: a community-based UI adaptation repository"* (FC-DI - Master Thesis). This master thesis (Costa, 2022) presents the design and user studies of (1) the first prototype of *GitUI* and (2) a template repository where users can publish and download personalization templates (not addressed in this document).

These publications address all our user studies. Therefore, the work we present in this document reproduces wholly or partially research that has been peer-reviewed and published. In this document, "we" denotes the authors of these publications.

1.7 Dissertation Structure

This dissertation is organized into seven chapters. Chapter 2 reviews the state of the art in UI personalization and complementary fields relevant to this work. It provides background and discussion on (1) inclusive design theories, (2) existing approaches to UI personalization, (3) factors shaping personalization practices, (4) community-based solutions to improve UI usability and experience, and (5) the use of interaction data to enhance UI quality. The chapter emphasizes how current personalization options remain misaligned with user preferences and highlights how community involvement and interaction data can further advance personalization solutions.

Following this contextualization, Chapters 3 to 5 describe the four research studies conducted in this dissertation, with Chapter 3 grouping the first two. Each chapter details the objectives, methodology, participants, materials, and results of the studies and situates the findings within the broader context of UI personalization and democratization.

Chapter 3 highlights that users desire more personalization options and greater control over UIs. Many of these preferences go beyond what pre-defined settings allow and often require programming skills. This chapter also discusses users' challenges in personalizing UIs, including availability, limited awareness of available options, difficulties conceptualizing improvements, and a lack of technical skills.

Chapter 4 investigates a solution for making personalization more accessible for users with limited availability or skills. It reports the results of our study exploring the dynamics of personalization assistance, showing that while people are willing to personalize for others, they struggle to identify opportunities for themselves. The chapter concludes with a discussion around potential strategies to support users in identifying personalization opportunities and, informed by the findings, introduces the concept of community-based personalization.

Chapter 5 studies the role of interaction data in supporting both the identification and implementation of personalization opportunities. The chapter explores how people envision mechanisms that assist with analyzing interaction data and personalizing based on it. It concludes with design considerations for integrating interaction data into user-driven personalization.

Chapter 6 consolidates the knowledge generated across the studies in this dissertation. It directly addresses each research question and introduces a novel design space that reflects the aspects users value, such as execution and decision-making support. The chapter concludes with examples of how this design space can be applied, including to evolve existing solutions and speculate on future systems.

Finally, Chapter 7 summarizes and contextualizes the contributions of this dissertation. It addresses (1) the evolution of UI personalization from the advent of graphical user interfaces to the present work, (2) the benefits and (3) limitations of this research, and (4) future directions for advancing the democratization of UIs through personalization.

Chapter 2

Related Work

This chapter contextualizes work that can support a personalized digital experience. Section 2.1 presents design theories that move beyond one-size-fits-all solutions. Section 2.2 provides an extensive description of personalization approaches and tools. Section 2.3 frames the factors impacting personalization adoption and use. Section 2.4 explores how community-based components have enhanced the overall digital user experience. Section 2.5 details how interaction data is currently used to improve UIs and empower end-users. Finally, Section 2.6 concludes with a summary of the chapter.

2.1 Design Theories

Designing UIs that account for the diversity of their user base has long been a goal in HCI. Several strategies aim to address this diversity either by supporting end-user modification at runtime or by anticipating a wide range of user needs during the design phase. For example, ***universal design*** (Mace et al., 1990) or ***design for all*** (Stephanidis, 1997), seek to create products that are accessible to as many people as possible by explicitly considering varied user needs and capabilities upfront, minimizing the need for adaptation. However, these approaches have been seen as utopian due to the challenge of designing a UI usable by anyone (Newell and Gregor, 2000).

As alternatives, ***inclusive design*** (Clarkson, 2004; Keates et al., 2000) or ***ability-based design*** (Wobbrock et al., 2011; Kong et al., 2024), advocate for designing technologies that can be adapted to take advantage of users' abilities. However, these approaches face practical challenges, as measuring users' abilities or physiological signals to adapt UIs remains complex (Mitchell and Wobbrock, 2024), and few mainstream UIs currently follow these strategies.

One promising pathway towards democratizing user interfaces involves rethinking end-users' role in systems design, balancing control between designers and users. In this context, the conceptual framework of ***meta-design*** advocates for creating systems that empower users to become co-designers during use (Fischer and Scharff, 2000). This

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shifting of control from designers to users is done by allowing "*owners of problems*" (i.e., end-users) to act as designers. It empowers users to engage actively in the development of systems at design and runtime. For example, at runtime, when users find the system unfit for their needs, they can require modifications.

To accommodate these unexpected needs at runtime, systems must be initially "*under-designed*" (Fischer et al., 2004). Creators of underdesigned systems should develop social and technical instruments so that users can create solutions themselves at runtime. The ultimate goal is to create conditions for collaborative design involving all stakeholders, empowering them to address their problems actively.

Meta-design does not assume that being a consumer or being a designer is a binary choice for the user (Fischer and Giaccardi, 2006). Consumers (i.e., passive users), power-users, and designers are educated, not born; therefore, there is a continuum evolution from a passive a role, to a well-informed meta-designer (Fischer, 2002). Building on the *division of labor* (Sawicki, 2003), Fischer (2002) observes that most citizens do not wish to create or design the products and systems they use, preferring to delegate such tasks to professional designers. At the same time, citizens are willing to take on a designer role for activities that are personally meaningful, while professional designers may act as passive consumers in areas that are less relevant to them.

Meta-design goes hand in hand with the concept of *evolutionary growth*, highlighting the importance of systems that evolve over time through continued collaboration of designers and users (Figure 2.1). This process involves *seeding* an underdesigned system, supporting *evolutionary growth* (a decentralized evolution of the system resulting from user adaptation and extension), and eventually *reseeding* the system by incorporating those changes.
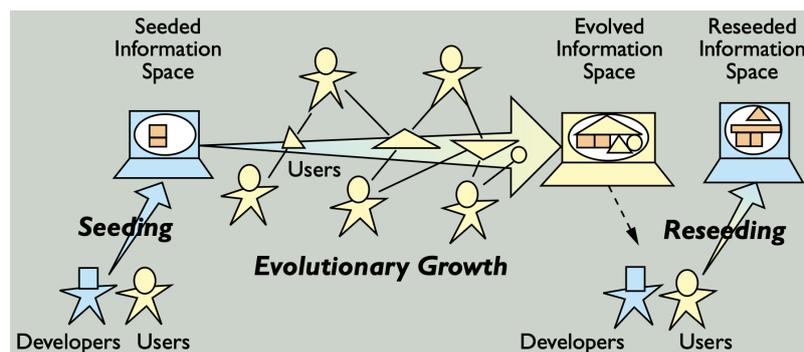
Figure 2.1: The process model that supports meta-design: *seeding*, *evolutionary growth*, and *reseeding*.

Meta-design generalizes the concept of **end-user modifiability**, also introduced by Fischer and Girgensohn (1990). *End-user modifiability* makes systems adaptable, arguing that in cases where designers have not anticipated specific activities, users must be able to modify the design. Despite promising to democratize the design of interactive systems,

"*underdesigned*" UIs that follow these concepts are rare.

Also aligned with the concept of democratization, **system appropriation** (Dix, 2007) emphasizes the role of users as active participants in shaping technology, extending, re-purposing, or adapting systems in ways not originally anticipated by designers. These adaptations often go beyond pre-programmed features, reflecting the creative and contextual modifications users make to align technologies with their specific needs, goals, and environments. Dix (2007) presents design guidelines to support appropriation, highlighting that while designers cannot predict the unexpected, they can design systems that allow for the unexpected. Designers can support appropriation by enabling pluggability (e.g., allowing users to plug components together in different ways), learning from users' appropriations and redesigns, or fostering social sharing of adaptations, which encourages users to inspire and learn from one another.

While system appropriation and meta-design emphasize user-driven modifications, a more recent approach, *EvolveUI* (Saif et al., 2024), explores how systems themselves can play a more active role in the adaptation process. *EvolveUI* is an automated design approach focusing on adapting UIs at runtime for enhancing digital navigation for less tech-savvy users. It advocates for developing interfaces that progressively expand, introducing new features and navigation elements as users become more familiar and confident with the system.

2.1.1 Discussion

We have witnessed the growth of multiple approaches to ensure that UIs account, by default, users' needs. However, these efforts have generally fallen short of fully addressing users' needs and have yet to be widely adopted by UI creators. Consequently, many UIs are currently unable to ensure a consistently satisfactory experience for their users, with extreme cases noticeable in inaccessible content that could be made accessible with simple tweaks (Wallace et al., 2022).

Other paths could be explored to facilitate the implementation of these design strategies and improve UI adaptability. For instance, micro-frontends (Geers, 2024) is a web development pattern that modularizes front-end applications, allowing different UI components to be developed, deployed, and updated independently while still integrating seamlessly with a shared back-end. Similarly, service-oriented architecture (SOA) (Perrey and Lycett, 2003) promotes the reusability and interoperability of software components through service interfaces, facilitating a separation of UIs from services. Together, these approaches provide a modular framework that could enhance adaptation to user needs. However, they primarily focus on technical flexibility rather than user-driven adaptability and may face challenges with unpredictable runtime user behavior.

Adapting to runtime behavior also requires going beyond designing for static user abilities, as users' capabilities and contexts are dynamic and shaped by situational factors

(Wobbrock, 2019; Kong et al., 2025). For example, a user might temporarily experience blurry vision after an eye procedure or experience reduced precision when interacting with a touchscreen while walking. These situationally-induced impairments can affect how users interact with UIs, highlighting the need for interfaces that adapt to different situations. This is where UI personalization can become crucial, serving as a bridge between inclusive intentions and real-world diversity in use.

We identify the following gap (GP):

(**GP1**) *Most existing UIs insufficiently support runtime adaptation to individual users' abilities, goals, and contexts.*

2.2   User Interface Personalization

UI personalization involves tailoring a UI to align with individual users' needs, preferences, and usage contexts. This section categorizes existing layout personalization approaches, distinguishing between built-in personalization, which is integrated into software by default, and third-party solutions, which externally extend or modify UIs. This distinction is important because built-in personalization typically limits users to predefined options set by developers, whereas third-party solutions allow for more flexible and open-ended personalization beyond the original design intentions. Simultaneously, personalization can be user-driven, where users actively modify UIs; system-driven, where the system performs UI adjustments automatically; or hybrid, offering some user control alongside automated adjustments. Table 2.1 summarizes these categorization.

2.2.1   Built-in Personalization

This section outlines software that can inherently adapt or be adapted to accommodate individual needs.

2.2.1.1   Adaptable Software

Adaptable interfaces are designed to give users control and initiative to modify predefined UI elements according to their preferences (Stuerzlinger et al., 2006; Findlater and McGrenere, 2004). This adaptation process can involve manually reordering or filtering menu items (Findlater and McGrenere, 2004; Park and Han, 2011; Park et al., 2007), creating a UI template or skin to apply (Saati et al., 2005), or constructing UI façades, simplified UI layers containing only user-selected elements (Stuerzlinger et al., 2006).

We see many successful cases of adaptable UI components in mainstream software. Examples include adjusting brightness, background, and color modes; resizing or reorder-

Table 2.1: Categorization of UI personalization approaches across user-driven, system-driven, and hybrid paradigms, as well as built-in versus third-party solutions. The terms used in this categorization are not formally established in the literature, although they were derived from recurring patterns across prior work.

Category	Built-in Personalization	Third-party UIs Repair
User-driven	*Adaptable software*: e.g., Microsoft Word customizable toolbar or color mode changes.	*Customization software*: e.g., Stylish (SimilarWeb, 2022b) or CrowdAdapt (Nebeling et al., 2013) for manual web page adjustments.
System-driven	*Adaptive software*: e.g., context-aware software, responsive or constraint-based layouts (Jiang et al., 2020), SUPPLE (Bunt et al., 2007a).	*Adaptation software*: e.g., automatic UI refinements (Wu et al., 2022).
Hybrid	*Adaptable software with system support or adaptive software with user control*: e.g., adaptive text size or high contrast mode based on users preferences (Faith Leroux, 2023).	*Mixed-initiative software*: e.g., external software enabling brightness change with manual adjustments (f.lux, 2024).

ing operating system (OS) widgets, shortcuts, and icons; modifying accessibility-related components such as font size; or customizing quick-access toolbars in applications like *Microsoft Office*. However, in most cases, user control and the extent of possible changes remain limited to a pre-determined set of options. Consequently, personalization is often parameterized, meaning that developers determine which modifications are allowed and which interface elements can be personalized.

When personalization extends to broader scopes (such as personalizing entire layouts or responding to contextual changes), it increasingly relies on system logic, making most built-in personalization features less user-driven and more aligned with the hybrid or system-driven approaches. These limitations have sparked interest in third-party solutions, from which much of the research on user-driven personalization has emerged.

2.2.1.2 Adaptive Software

Self-adaptive and **context-aware** software dynamically adjust their functionalities or UIs at runtime in response to user behavior or environmental changes (Motti and Vanderdonckt, 2013; Liu et al., 2024; Kong et al., 2025; Gaspar-Figueiredo et al., 2025b). These systems use sensor data and follow a rule-based process to autonomously perform configuration changes or parameterization. One example is *Split Adaptive Interfaces* (Gajos and Chauncey, 2017), which predicts the most relevant functionalities to the user and moves

them from the original location to an adaptive shortcut toolbar. A study with 16373 participants showed that while most people benefit from these interfaces, their effectiveness varies from person to person.

The proliferation of devices such as smartwatches and smartphones has brought numerous adaptive features, including automatic brightness adjustment, location-based reminders, and screen size responsiveness. We also have witnessed an intention to facilitate the execution of these features. A recent example is *FrameKit* (Wu et al., 2024b), a programming-by-example software for developers to create adaptive UIs based on keyframes.

Users enjoy context-aware components, although they feel a lack of control over those features (Barkhuus and Dey, 2003). Van Der Heijden (2003) suggested that adaptive solutions that shift control from users to the system increase users' anxiety. Studied solutions to improve users' experience with adaptive software have focused on keeping users in the loop. This includes allowing them to select application variants, control (e.g., postpone or undo) system adaptations (Evers et al., 2014), provide feedback on the adaptations (Yigitbas et al., 2019), express their adaptation needs (Kühme, 1993), or adapt only certain UI components (Gajos and Chauncey, 2017; Khamaj and Ali, 2024).

Adaptive and context-aware features are also often part of broader concepts, as with UI plasticity, intelligent UIs, or intent-based UIs. **UI plasticity** refers to UIs' ability to be plastic, in the sense that they preserve usability by adapting it to the context of use (Yigitbas et al., 2019; Coutaz, 2010; Coutaz and Calvary, 2012). Plastic UIs can include both adaptable and adaptive features (Miraz et al., 2021), enabling users to adjust the UI or do it automatically, respectively. **Intelligent UIs** consist mainly in adaptive interfaces that automatically adjust their characteristics according to a pre-defined strategy (Tajja et al., 2024; Völkel et al., 2020; Stephanidis et al., 1997; Abrahão et al., 2021). Similarly, **intent-based UIs** dynamically adjust to align with users' task types and goals (Ding, 2024).

Adaptive UIs are often automatically generated through **model-based approaches** (Ahmed and Ashraf, 2007; Puerta et al., 1994; Puerta, 1997; Castillejo et al., 2014; Abrahão et al., 2021; Peissner and Edlin-White, 2013; Cao et al., 2025), which allow the design of interactive systems based on a set of adaptation rules. These rules are explicitly created by UI creators or deducted from users' interaction using machine learning techniques (Langley, 1997). For instance, Hussain et al. (2018) proposed a system for building and managing UIs based on existing user, context, and device models. While the system increased efficiency, it was generally perceived as less aesthetic, generated consistency concerns, and reduced the learning rate. Another example is *SUPPLE* (Gajos and Weld, 2004; Gajos et al., 2010), a system that generates interfaces tailored to individuals' devices, tasks, preferences, and abilities. Results from a study with people with motor impairments demonstrated that the UIs automatically generated by *SUPPLE* improve speed, accuracy, and satisfaction. However, the adaptation spectrum was limited to

dialogue boxes.

Model-based UIs are not entirely accepted (Myers et al., 2000). They can remove brands' identity through the automated design, tend to stereotype users into groups, and suffer for calculating acceptable values for why and when to adjust UIs (Abrahão et al., 2021). Users also change over time, resulting in dynamic personalization needs that systems may not recognize, leaving them stuck with outdated user perspectives (Oinas-Kukkonen et al., 2022).

Another form of adaptive UIs is **culturally adaptive UIs** (Reinecke and Bernstein, 2011; Alsswey et al., 2020). The idea is to automatically compose interfaces based on the cultural backgrounds of its users. In a study with 41 participants of different cultural backgrounds, Reinecke and Bernstein (2011) showed that most preferred their culturally personalized interfaces over a non-adapted version. Additionally, participants were 22% faster using the culturally adapted interface.

2.2.1.3   Hybrid Approaches

Hybrid or mixed-initiative approaches combine the advantages of customization and adaptation while reducing some limitations, typically following either an adaptable approach with system support or an adaptive approach with user control. These systems typically propose personalization suggestions that users can accept or reject and are mainly studied in the context of menus personalization (Debevc et al., 1996; Park and Han, 2011; Bunt et al., 2007a, 2009). An example is the *MICA* system (Bunt et al., 2007a, 2009), which provides suggestions on how to personalize the menus of a word processor. These suggestions are influenced by users' expertise with the word processor or the expected usage. Results from a study comparing the mixed-initiative approach with a purely adaptable alternative indicated participants' preference toward the mixed-initiative approach. Park and Han (2011) performed a similar experiment, comparing two mixed-initiative interfaces with adaptable, adaptive, and static UIs. The experiment results show that people prefer an adaptable UI with system support over an adaptable or static UI, as the system support can reduce the time necessary to personalize (people make faster personalization decisions).

2.2.1.4   Discussion

People interact daily with different forms of UI personalization embedded in mainstream UIs. They actively use mechanisms like changing background or color modes (Häkkilä and Chatfield, 2006). However, this personalization offer is often minimal, especially considering software diversity, the dynamics of human behavior, and identified user personalization needs, like moving and resizing UI elements (Nebeling et al., 2013). For instance, although people advocate for color modes (Andrew et al., 2024; Andrew and Tigwell, 2025), most applications do not support this personalization (Ma et al., 2023) or

do not take full advantage of it (Andrew et al., 2024). Among the reasons for developers not providing dark modes is the lack of knowledge of how to implement them and the lack of standards to follow (Ma et al., 2023).

Moreover, there is a mismatch between the perceived and actual capacity for personalization in software, a phenomenon known as *Personalization Myopia* (Oinas-Kukkonen et al., 2022). Both designers and users may overestimate the characteristics and availability of personalization features, assuming systems are more adaptable than they truly are.

Most importantly, UI designers cannot foresee all the different forms people will use a UI in practice (Stuerzlinger et al., 2006). Although these approaches ensure some flexibility, they still fall short in ensuring full adjustment to users' needs. Coutaz (2010) identified several limitations of the state of UI design:

- Tools are created for software professionals, not common users.

- End-users are forced to accept what designers assume suits their target audience.

- Runtime adaptations focus on context changes and on what is deemed essential by the developers. In other words, **the adaption possibilities are constrained by design**.

We identify the following gap:

(**GP2**) *Most built-in personalization options constrain the scope of personalization, limiting user agency and failing to support diverse or evolving needs.*

2.2.2 Third-Party Runtime Personalization

Researchers and practitioners have been exploring third-party runtime repair solutions to deal with the lack of built-in components to mold UIs to users. This section presents existing work on third-party UI personalization, including adaptation and customization.

2.2.2.1 Adaptation

Adaptation approaches rely on a series of pre-defined rules and on data collected from users to adjust interfaces automatically (Kumar et al., 2011; Reinecke and Bernstein, 2011; Duan et al., 2020; Wu et al., 2022; Gaspar-Figueiredo et al., 2025a). A proposed approach is *Reflow* (Wu et al., 2022). To improve touch efficiency while minimally disrupting the design intent of the original UI, *Reflow* automatically personalizes UIs of mobile app screens using a pixel-based adaptation strategy. The system extracts a layout from a screenshot, refines it using machine learning, and re-renders a personalized
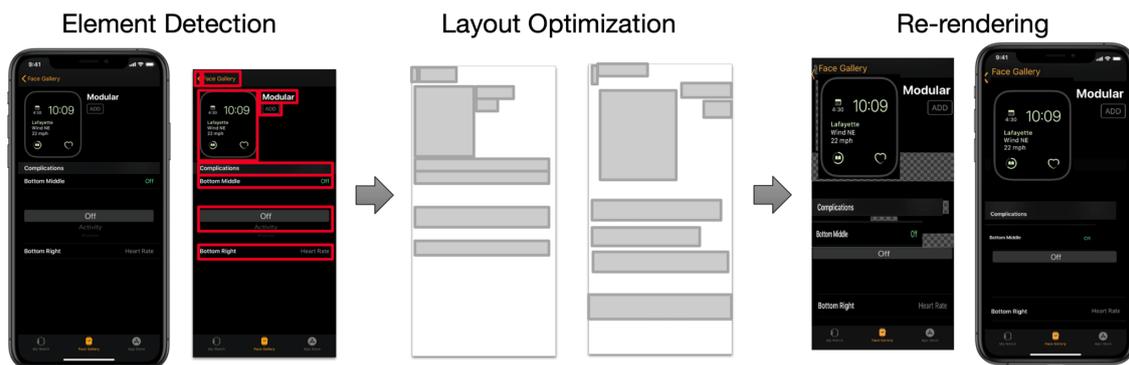
Figure 2.2: *Reflow* (1) detects UI elements directly from pixel data, (2) optimizes the layout based on a personalized difficulty model, and (3) re-renders the UI with an updated layout. In the example shown, *Reflow* produces a new interface with larger and more widely spaced buttons.

UI (Figure 2.2). A spatial map constructed from usage data, which identifies difficult-to-access areas of the screen, informs the system. A study with 10 participants showed that *Reflow* can reduce, on average, the selection time by 9%.

Alternatively, **example-based** approaches (Kumar et al., 2011; Lee et al., 2010; Fitzgerald et al., 2008), such as *Bricolage* (Kumar et al., 2011), allow the transfer of design and content between web pages by creating coherent mappings between similar elements. These mappings, generated through crowdsourcing, allow content from one page to adapt automatically to the style and layout of another. This concept aligns with *bricolage theory*, which focuses on repurposing existing resources or structures to serve new ends (Johnson, 2012). UI retargeting (Chen et al., 2021; Chen and Grossman, 2021) systems follow a similar approach, although they mainly were studied to support the work of designers. For instance, *Umitation* (Chen and Grossman, 2021) supports extracting and retargeting dynamic UI behavior examples from existing to new (target) websites. While "*borrowing*" UI behaviors, users can also adjust UI design properties such as width or opacity.

2.2.2.2 Customization

UI customization software allows for more tuned manual adjustments at the expense of more time invested by users (Nebeling et al., 2013; Bila et al., 2007; Häkkilä and Chatfield, 2006; Zeidler et al., 2013; Kim et al., 2022; Aldalur et al., 2024; Wood et al., 2023; Miller et al., 2010). One example is *CrowdAdapt* (Nebeling et al., 2013). *CrowdAdapt* (Figure 2.3) is a direct manipulation toolkit that enables users to customize any website with seven operations: *move*, *resize*, *spacer*, *hide*, *collapse*, *font size*, and *multi-column*. A crowd-based component allows the system to look for different crowd adaptations matching users' settings and automatically adapt a web page. An experiment with 93 participants showed that customization can improve the browsing experience. The *move* and *resize* operations were particularly relevant to participants.
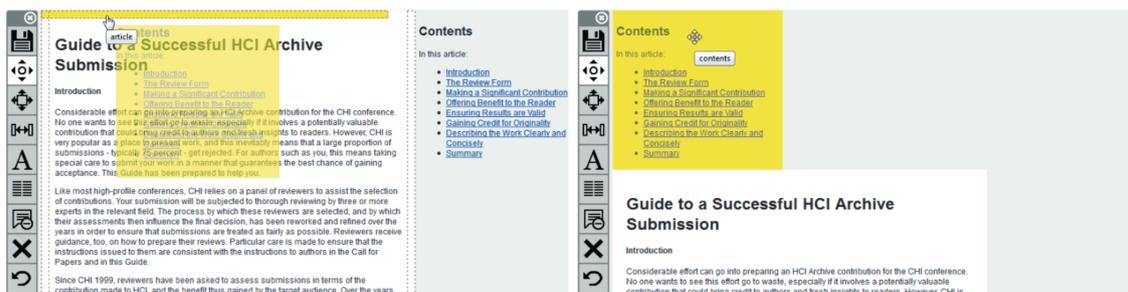
Figure 2.3: Demonstration of *CrowdAdapt*'s move operation, with the original layout on the left and the modified version on the right. The left sidebar allows users to select among seven personalization operations.

Similarly, Bila et al. (2007) addressed mobile-specific customization needs with a technique called *Reusable End-User Customization*. Their prototype, *PageTailor*, allows users to customize web pages by directly manipulating the graphical objects on the screen. When browsing a web page, users can open the *PageTailor* customization interface (a toolbar with six operations: remove, increase, decrease, move, undo, and done) to modify the layout. The system automatically reapplies customization on subsequent visits to the same page or similar pages on the same website. Two controlled experiments confirmed that users can successfully customize web pages.

A concern specific to customization is the decomposition of users' high-level goals into the low-level operations provided by customization tools, something found in other design-related tasks (Adar et al., 2014). To this end, Kim et al. (2022) introduced *Stylette*, a tool allowing users to customize websites using natural language commands. Users can use their voice to express their goals and interact with a set of design alternatives the system presents. The tool's workflow is the following: (1) select an element; (2) provide voice instructions with the desired change; and (3) select, in a toolbox, the change to apply. This toolbox allows users to experiment with different style values and properties. The authors conducted an initial study with eight non-experts to inform the tool's design. During the experiment, participants verbally requested styling changes, which researchers then implemented. The results showed that non-expert users often make customization requests that are vague, lacking specific details (e.g., background color) or relying on abstract terms (e.g., "*modern*" or "*vivid*"). They also prefer not to dedicate their mental effort to reasoning about personalization details, expecting support from an expert instead. In a second study, to evaluate *Stylette*, the authors found that the voice interaction started to limit participants' productivity as they acquired more knowledge with the tool. Natural language interaction was useful in providing quick familiarization with the customization tool, but gradually, people started seeking more direct interaction methods.

Customization capabilities are also often offered by accessibility solutions, as with **accessibility overlays** (Raising the Floor, 2022; accessiBe Inc., 2022). Accessibility over-

lays present themselves as a solution for Web accessibility by providing compliance with the *Web Content Accessibility Guidelines* (WCAG) and the *Americans with Disabilities Act* (ADA). They work as plug-in tools that modify websites using *JavaScript*. These overlays try to detect and fix basic accessibility issues within a website and also provide operations that users can use to modify their experience while on the website (e.g., changing the font size or color). However, accessibility overlays are struggling to be accepted by their possible users (Girma, 2021) and accessibility experts (Groves, 2022). One reason for this resistance is that website owners purchase and integrate these overlays, generally assuming they will make their sites accessible. However, these tools cannot ensure full compliance with accessibility guidelines (Egger et al., 2022) and may even generate incompatibilities with mainstream screen readers (Groves, 2022; Makati et al., 2024).

Ultimately, UI Customization is highly related to other concepts, including **end-user development** (EUD) or web augmentation. EUD consists of methods, techniques, and tools that allow non-experts to modify or extend a software artifact (Paternò, 2013; Paternò and Santoro, 2019). The concept acknowledges that even well-designed systems cannot foresee all user requirements and includes activities ranging from customization to components configuration and programming (Fischer et al., 2004). EUD encourages users to participate actively in software design and development during both design and runtime (Paternò and Santoro, 2019).

Customization can also be seen as part of broader practices such as **web augmentation**, which involves modifying or enhancing existing web pages (typically in the user's browser) without changing the original source code or backend (Aldalur, 2023; Díaz, 2012; Díaz et al., 2010; Bosetti et al., 2017; Leshed et al., 2008). Web augmentation spans both scripts and layout, but traditionally, it has had a stronger focus on scripting and behavioral changes. For example, *Greasemonkey* (Pilgrim, 2005; Díaz et al., 2010) and *Tampermonkey* (Biniok, 2022), primarily used for behavior customization, enable users to write custom *JavaScript* that runs on any website. These user scripts can be shared in online repositories (e.g., *greasyfork.org*), creating a community ecosystem where users contribute, adapt, and reuse personalization solutions.

Also aligned with end-user programming practices, other forms of customization, such as **mashups**, reflect users' intent to configure and personalize their digital environments manually. Mashups (Daniel and Matera, 2014; Tuchinda et al., 2008) involve creating entirely new interfaces or applications by combining content, services, or functionality from multiple sources, often via public APIs (Benslimane et al., 2008; Guo et al., 2022). For example, mashups allow the integration of a calendar, map, and task list into a single productivity dashboard. Unlike web augmentation, which modifies existing interfaces, mashups typically result in standalone applications customized for specific user needs.

2.2.2.3 Hybrid User Interface Repair Personalization

Despite being valuable, customization approaches often rely on low-level manual adjustments that can become tedious and effortful (Mackay, 1991; Park and Han, 2011). Hybrid repair solutions aim to ease users' customization efforts and streamline the process, proving customization can still be user-driven without requiring manual UI manipulation. For instance, Bonavero et al. (2015) proposed an algorithm to adapt web page designs to the needs of visually impaired users, balancing user preferences (e.g., font size, text color, brightness) with the designer's original intent. Users do not need to manipulate the UI manually but rather to define their preferences. These preferences may include font size and family, text color, spacing, brightness, and contrast. The algorithm manages cases where these preferences conflict with each other or with the designer's choices. Another example is *UIFlex* (Proença et al., 2021), a browser extension that collects the skills and abilities of its users (through a questionnaire) and, based on a set of rules, makes personalization suggestions. A study with 104 participants suggests that the solution improves satisfaction and efficiency with UIs.

2.2.2.4 Discussion
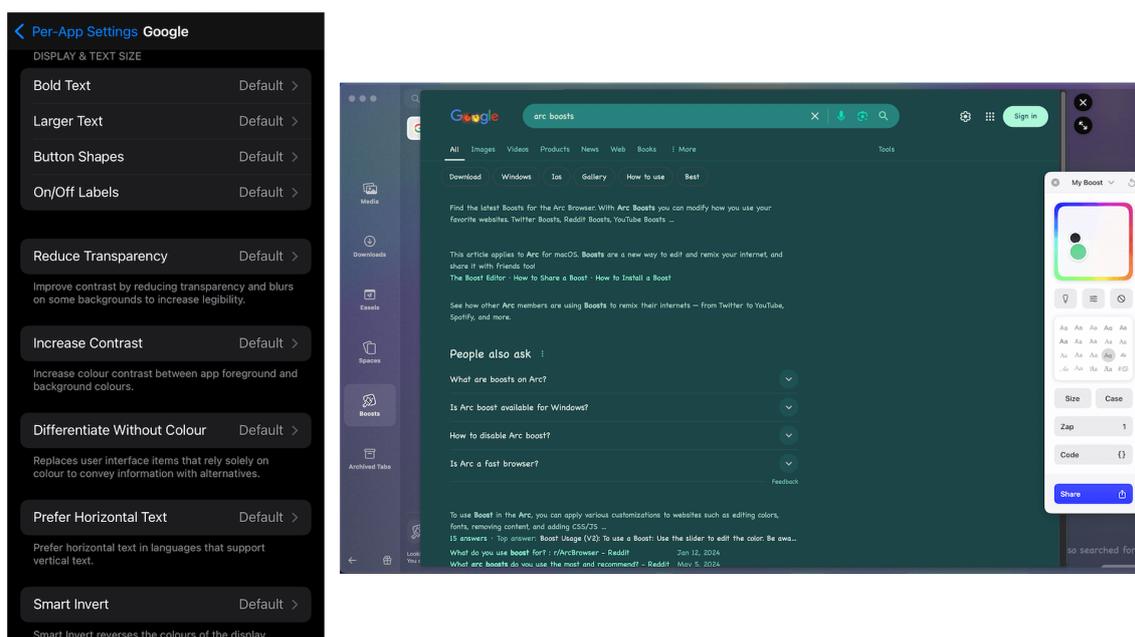
Figure 2.4: Examples of repair personalization settings: *iOS* per-app accessibility settings (left) and *Arc* browser boosts (right). These features enable users to modify color and font properties across applications or websites.

These works showed that people are interested and can benefit from personalization beyond the embedded offer. However, few meaningful UI repair options are currently available to non-technical end-users, most of which are associated with accessibility con-

figurations. Browsers allow for zooming in/out or activating the reader mode; operating systems, like *iOS* (Apple Inc., 2022), allow users to set individual application preferences, including button shapes, contrast, or font (Figure 2.4, left); and browser extensions allow users to configure text (Ryzal Yusoff, 2024), links (Simon Lydell, 2024), windows (Bozozo, 2013), colors (P. Wang and H. Zhou, 2017), or control advertisement (Adblock, 2024). A more recent example is the cross-platform browser *Arc* (The Browser Company, 2024), which lets users configure webpages' colors and font properties or execute personal scripts and CSS (Figure 2.4, right).

However, as with built-in features, many users remain constrained to the set of pre-defined or parameterized personalization options made available by designers. When non-expert users wish to personalize beyond these options that designers deem relevant, such as performing very specific and unique adjustments, they are often left without solutions. While powerful tools like *Stylish* (SimilarWeb, 2022b) and *Tampermonkey* (Biniok, 2022) offer high degrees of customization through code injection, they require programming expertise. This creates a barrier, preventing many non-expert users from fully benefiting from the potential of UI personalization.

Moreover, this limitation contributes to a lack of understanding of how users, especially non-experts, would engage with personalization environments that offer an unrestricted extent of personalization and support transformative changes, allowing them to freely tailor user interfaces to their own needs and preferences, potentially in unconventional ways.

Finally, studying how existing solutions fit into users' digital practices and needs is also important. For example, most personalization features have been proposed within the domain of accessible computing, where extreme differences in abilities often necessitate tailored solutions. Still, many of these features remain unknown to users (Wu et al., 2021), even when integrated into operating systems (Heron et al., 2013b). Consequently, users frequently fail to take full advantage of settings that could benefit them (Research, 2004), raising the question of how this general lack of awareness might extend to UI personalization at large and what factors can be decisive for UI personalization adoption and use.

We identify the following gaps:

(GP3) *Advanced personalization options that enable meaningful, unrestricted personalization remain inaccessible to non-experts. Furthermore, there is limited understanding of how these users would engage with personalization environments where such capabilities are available.*

(GP4) *There is a limited understanding of users' awareness and actual usage of*

existing personalization features, including both built-in and third-party
solutions.

2.3   Understanding Personalization

Understanding which factors affect UI personalization is crucial to guiding our research. In this subsection, we delve into the key factors influencing the design, execution, and adoption of personalization mechanisms, considering the different approaches and their respective advantages and limitations.

2.3.1   Human Factors, Personality, and Personal Characteristics

Multiple human factors influence UI personalization. Marathe and Sundar (2011) found a relationship between customization, a **sense of control**, and a **sense of identity**. Furthermore, a sense of identity seems to trigger a sense of control. Sundar (2008) argues that customization enhances **personal agency** and helps shape **self-representation** by enabling interfaces to present more relevant content. Lallé and Conati (2019) found that visualization (the ability to extract information from data representation) and locus of control (the extent to which people believe they can control the events affecting them) impact customization effectiveness. Exposure and awareness of customization features and social influence can also affect the users' customization behavior (Banovic et al., 2012) and trigger a desire to customize (known as breaking point).

The 5-factor personality traits (openness, conscientiousness, extroversion, agreeableness, and neuroticism) also influence how people customize or use personalized UIs (Saati et al., 2005). For instance, there is a correlation between color preferences and extroversion, conscientiousness, and openness. Other personality traits affecting personalization are the need for cognition (tendency to engage in and enjoy effortful thinking), uniqueness (desire to be different from other people), and variety-seeking (motivation to look for or accept novelty). For example, people with a higher need for cognition or uniqueness value personalization more than variety-seekers (Ho et al., 2008).

Other factors, like tech-savviness, age, or gender, can influence people's understanding and reaction to personalization. In a work focused on content personalization, Sundar and Marathe (2010) found that less tech-savvy users have negative attitudes toward customizing an interface but respond positively to an already personalized one. Conversely, tech-savvy users had more positive attitudes and felt greater control when allowed to customize. Privacy is also a significant factor, as these findings were especially evident for those who provided access to their browsing data. Similarly, studying an adaptive icon toolbar, Debevc et al. (1996) observed that novice users benefited from mixed-initiative personalization components, while expert users showed the opposite behavior.

Brandenburger and Janneck (2024) also found age and gender influence people's design preferences, including how they value different shapes, although people's assumptions about their preferences often differ from what they actually like (Kahneman and Snell, 1990).

Wood et al. (2023) explored the factors influencing why and when users choose to personalize, summarizing much of the existing knowledge. They proposed a seven-stage personalization lifecycle model: *motivation*, *estimation*, *consideration*, *exploration*, *confirmation*, *evaluation*, and *integration*. These stages cover personal beliefs to personalize, solution hypnotization, effort estimation, or outcome evaluation.

2.3.2 Perceived Trade-offs of User- and System-Driven Personalization

The perceived advantages of user- and system-driven personalization are often related to the **control** people desire and the **effort** and **privacy** they are willing to provide, creating cost-benefit trade-offs associated with these factors (Peissner and Edlin-White, 2013; Sundar and Marathe, 2010). User-driven approaches do not require personal data collection and provide a higher sense of control and identity (Sundar, 2008; Marathe and Sundar, 2011). However, users need to invest significant time and effort, which may outweigh personalization benefits (Bunt et al., 2007a) and result in a tedious personalization process (Kim et al., 2022). Ultimately, we can associate the cost-benefit trade-off of user-driven personalization with value-based decision-making, which involves "*trading off the cost associated with an action, such as physical or mental effort, against its expected reward*" (Sidarus et al., 2019).

Conversely, while system-driven personalization minimizes user effort, it diminishes the sense of control and raises privacy concerns due to the extensive data collection required by these processes (Sundar and Marathe, 2010). For instance, tech-savvy users react differently from non-tech-savvy users to system-driven approaches, which can be a consequence of their higher awareness of how collected browsing data can be used (Sundar and Marathe, 2010). Content personalization research describes this relationship as the personalization privacy paradox (Xu et al., 2011; Chellappa and Sin, 2005). Nevertheless, personalization benefits can override these types of privacy concerns (Xu et al., 2011), as there is a relationship between personalization, perceived value, and willingness to disclose information.

System-driven strategies where UIs change suddenly and automatically can also confuse, disorientate, and interfere with users' mental models (Peissner and Edlin-White, 2013; Shneiderman et al., 2016). This, ultimately, reduces UIs usability and creates a cost-benefit trade-off for usability (Paymans et al., 2004). Strategies to deal with confusion include favoring non-destructive approaches (Deuschel and Scully, 2016; Findlater et al., 2009), adapting only certain areas of the screen, making users aware of changes,

and asking for confirmation, as with mixed-initiative strategies (Bunt et al., 2009; Debevc et al., 1996).

Overall, users who value system-driven approaches tend to prioritize the outcomes (i.e., the personalized UI), while those who favor user-driven approaches focus more on the personalization processes, motivated by a sense of agency (Sundar and Marathe, 2010).

Jameson (2007) translated this understanding of personalization into six design considerations for adaptable or adaptive interfaces: *predictability* and *transparency* (the extent to which users can predict and understand the effect of their actions), *controllability* (the extent to which users can prevent particular actions or states of the system), *unobtrusiveness* (the extent to which the system places demands on users' attention), *privacy* and *breadth of experience* (the extent to which the system helps users with some form of information acquisition).

2.3.3 Discussion

Overall, user-driven personalization solutions often demand substantial time and effort (both physical and cognitive) from users. Past research has aimed to reduce this burden by shifting control over personalization decisions and execution to the system side. However, this shift can diminish users' sense of agency and control over the personalization process.

As UI democratization revolves around giving agency to individual users, existing literature should be strengthened with more knowledge about what users really want and need to personalize. Understanding how humans react to personalization can also be further enhanced, especially given that much of the work presented in this section focuses on content personalization.

Moreover, it is essential to understand how to facilitate access to personalized UIs for different types of users. In this sense, user-driven approaches can be challenging for users, especially when addressing their needs requires significant creativity, time, or programming skills (Paternò, 2013; Mackay, 1991). This challenge can be particularly critical for non-experts, as the gap between personal experience and technical knowledge, referred to as the novice–expert divide (Wood et al., 2023), highlights that while end-users are experts in their own needs and experiences, most lack the necessary technical knowledge of professional designers.

Possible suggested directions to lower the barriers of programming include programming-by-demonstration (Myers and Buxton, 1986; Little et al., 2007), example-based personalization (Kumar et al., 2011), or the introduction of collaborative components (Fischer et al., 2004; Little et al., 2007; Pilgrim, 2005; Díaz et al., 2010; Paternò, 2013; Leshed et al., 2008). While the first two approaches still constrain users within the boundaries predefined by developers, collaborative components offer greater potential for fostering user independence, an aspect explored in the context of this thesis.

We identify the following gap:

(**GP5**) *Most user-driven personalization solutions fail to balance controllability, effort, and required expertise, limiting meaningful, in-depth personalization, especially for non-expert users.*

2.4 Community-Based Approaches to Improve User Interfaces

We see a community-based approach as a solution to deliver personalization to people lacking the necessary skills and availability to customize. Collaboration among end-users is considered a key feature in EUD (Paternò, 2013). The idea is to allow people who need a solution to a specific problem to interact with a broad community that shares similar interests and to try to obtain a suitable solution for it. End-user groups of these communities are typically very heterogeneous, as members have different technical and social backgrounds. This diversity makes the concept interesting even for tech-savvy or experienced users, who can face complex problems requiring more knowledge than they possess (Paternò, 2013).

The community concept is generally under-explored in the context of UI personalization but is common in other research fields. This section describes how community-based components have been used to improve UIs.

Collaboration among UI personalization users was first explored by Nebeling et al. (2012), who introduced the notion of ***crowdsourced Web site components***. These components, which include evolutive blocks of content, presentation, or behavior, enable the continuous refinement of a website's design with the help of the crowd. In this scenario, non-experts can build their components based on those created by more experienced users. This work informed *CrowdAdapt* (Nebeling et al., 2013). *CrowdAdapt* was, to the best of our knowledge, the only user-driven personalization tool (requiring no scripting) that enabled users to obtain adaptations made by others. Created adaptations were automatically shared with other users and automatically applied according to the user's settings when visiting a web page. Users could also preview different adaptations, which were sorted by the number of positive votes. While users enjoyed the concept of sharing customized layouts, the tool has since been discontinued and is no longer publicly available.

A more recent work is *CrowdUI* (Oppenlaender et al., 2020). The system allows members of a website's community to visually express their design improvement ideas, frustrations, and needs by using the website as a canvas. The tool aggregates data as heatmaps and informs the website's owner about the needs and preferences of the community. Novice users were the most open to using the tool, while experts were not in-

clined to use their own modifications or the modifications created by other users. This
role separation is, in fact, common in crowd-based tools. For instance, Akiki et al. (2013)
presented a mechanism for crowdsourcing UI adaptations in enterprise applications: (1)
enterprise users adapt a UI using an editing tool; (2) the system verifies if the adapta-
tion creates any conflicts; and (3) an administrator checks, integrates, and publishes the
crowd-adapted UI. Enterprise users with the appropriate roles can then use and rate the
adaptation. *Reform* (Toomim et al., 2009) is another example: programmers author site-
independent web enhancements, and non-experts can attach them to the websites they
use.

Crowd-based or collaborative components are common in personalization tools that
focus on user behavior and scripting (Little et al., 2007; Pilgrim, 2005; Díaz et al., 2010;
Biniok, 2022). For instance, *CoScripter* (Leshed et al., 2008) allows users to record,
share, and automate web tasks. It combines a centralized script repository with a *Fire-
fox* extension that facilitates both the creation and execution of scripts. Results from an
interview study indicated that users were interested in using *CoScripter* to share how-to
knowledge, teach tasks to others, promote useful information sources and teach people
how to access them, and learn how to use the tool by examining or repurposing scripts
created by others.
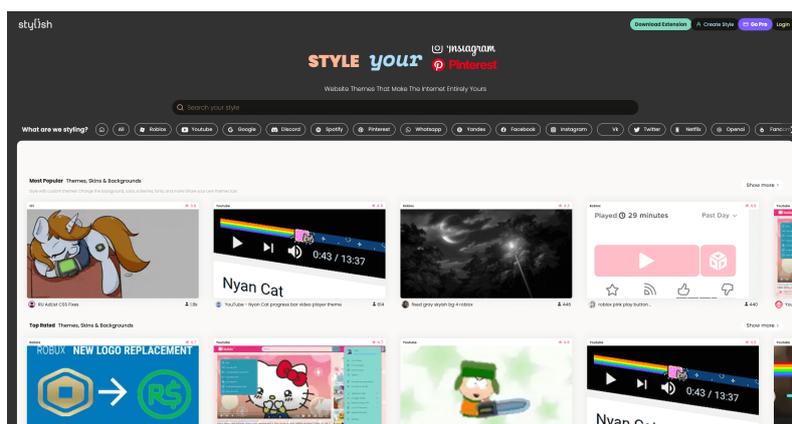
Figure 2.5: The *Stylish* (SimilarWeb, 2022b) public repository, where people can consult
and install themes, skins, and backgrounds.

Two mainstream personalization solutions, *Stylish* (Figure 2.5) and *Tampermonkey*
(Biniok, 2022), allow users to create and share *CSS* and *JavaScript* adaptations, respec-
tively. However, in both, users must write code to customize and do not have any as-
sistance mechanism, yet it is possible to install adaptations of others. In the recently
released Web browser, *ARC* (The Browser Company, 2024), it is possible to share and
install public personalization "*boosts*", which may include *CSS* instructions and simple
UI operations. Another successful example of community-based UI adaptations comes
from the gaming community, where players customize UIs and share them with the rest
of the community (Dyck et al., 2003; Reay and Wanick, 2023).
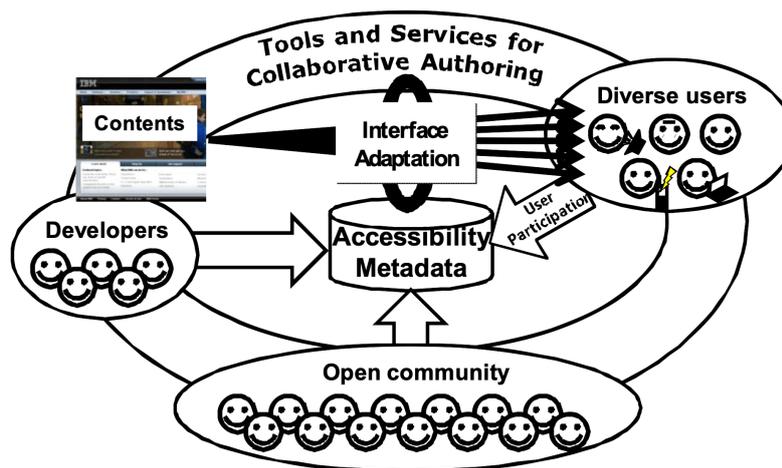
Figure 2.6: The *Social Accessibility* approach enables users with diverse accessibility needs to report usability issues, which community volunteers can collaboratively address.

We have also seen the successful application of these concepts in accessible computing. Takagi et al. (2008) introduced the concept of **Social Accessibility**. The idea is to make existing content accessible by using the power of the open community. When users encounter an accessibility problem, they can report it to a social computing service. Volunteers then discuss, create, and publish a fix. Figure 2.6 illustrates the *Social Accessibility* concept.

Another example is the *Social CheatSheet* (Vermette et al., 2017). This interactive information overlay can appear atop any existing web application and retrieve relevant step-by-step instructions and tutorials curated by other users. The system offers several features for users to search for community-generated help content or ask questions and clarifications. Similarly, Rodrigues et al. (2021) developed an interactive smartphone assistant, *RISA*, that applies human-powered accessibility approaches to create pervasive task assistance for blind and visually impaired people while using their smartphones.

2.4.1 Discussion

In these personalization approaches, there is no communication or mutual help between users. Users are either not in control of the personalization details (for instance, when users install adaptations offered by the crowd) or, if they seek control, they may not possess the required skills or availability to customize. This approach risks undervaluing and limiting end-users, despite evidence that even less tech-savvy individuals can provide valuable aesthetic judgments (Heer and Bostock, 2010; Redi et al., 2013) and are experts in their own experiences (Wood et al., 2023).

Open-source software repositories, such as *GitHub* (Dabbish et al., 2012), are a good example of how collaboration can improve software quality and streamline its development. Open-source development involves a community of developers who share knowl-

edge or work together to program pieces of code that address shared challenges and provide mutual benefits. Often, the original code of an open-source software represents a seed that can be evolved and reused by other developers.

In this dissertation, we expanded previous work by studying how human-powered mechanisms and collaboration can be used to provide direct personalization assistance to those who lack the skills or time to do so. We aimed to study a collaborative environment in which personalization is (1) driven by the user, (2) tailored, and (3) requested, rather than being passively offered or made available.

We identify the following gap:

(**GP6**) *While community-based approaches are common in platforms that enable the sharing of alternative UI layouts in public spaces, there is still no collaborative ecosystem in UI personalization where users can actively exchange knowledge, support one another, and co-develop personalized interfaces.*

2.5 Decision-Making in UI Personalization and the Role of Interaction Data

Complete control of the personalization process requires users to be able to make informed personalization decisions. User-driven personalization research showed it is essential to make users aware of personalization benefits to enable a fair cost-benefit analysis and increase users' willingness to personalize (Mackay, 1991; Banovic et al., 2012). Similarly, system-driven mechanisms benefit from increased transparency, predictability, and trust, as well as from the ability to demonstrate usefulness (Barkhuus and Dey, 2003; Sundar and Marathe, 2010). In this sense, enabling end-users to access, visualize, and reflect on their interaction data (such as click activity, navigation paths, or scroll depth) can be important for enhancing both user- and system-driven personalization strategies.

Personal interaction data has been explored to enhance the diverse types of personalization and overall users' digital experiences. Considering UI personalization, system-driven solutions frequently use personal interaction data to construct spatial maps from usage data (Wu et al., 2022) or develop recency- or frequency-based algorithms to adjust UI elements (Gajos and Chauncey, 2017). On the other end, user-driven approaches typically do not collect personal interaction data, and mixed-initiative approaches avoid collecting users' interaction data by resorting to user models, able to predict users' performance or actions based on personal characteristics or needs (Proença et al., 2021; Bunt et al., 2007a).

Ultimately, hybrid solutions would benefit from further exploring usage data to improve suggestions. For instance, *MICA* (Bunt et al., 2009) explored presenting estimated time savings and personalization suggestions rationale, offering insight into how the system operates but not into how users' data drives those suggestions. A study with sixteen participants (Bunt et al., 2007b) revealed that time savings could motivate suggestions acceptance, although some participants believed the amount of time savings was too small and the presented information was difficult to understand or relate to. Participants found the suggestions' rationale important but common sense and expected it to include personalized information and graphical data.

Interaction data currently drives content personalization by supporting targeted advertisement (Lina and Setiyanto, 2021), recommender systems (Gupta and Rawat, 2016), personalized search engines (Toch et al., 2012), and online marketing strategies (Plaza, 2011). It is also crucial for informing iterative UI design and development, helping designers refine interfaces based on real user behavior (Muresan, 2009). Development teams typically use web analytics systems to understand what tasks users try to accomplish on a website or the difficulties they experience in completing those tasks. For instance, *Google Analytics* (Ledford et al., 2011) aggregates statistics, including the number of visitors, the average number of page views per visitor, the average page duration, or the most requested pages. Complementary techniques involve capturing traffic, clicks, and touches (Kaur and Singh, 2015; Hong and Landay, 2001; Harty et al., 2021).

Although people's use and control of personal interaction data is scarce, their use of other types of data is becoming a trend, in both personal and professional contexts. Individuals self-track physical activities, diet, or psychological states, either as n=1 self-experiments or in group contexts (Swan, 2013). With a personal motivation, digital data is also frequently used to support behavior changes, aiming to form and break habits (Pinder et al., 2018; Chagas and Gomes, 2017), reduce risk behaviors, or support and reinforce health behaviors (Fitzgerald and McClelland, 2017). Interestingly, these movements align with feelings associated with personalization as they both increase the sense of ownership, identity, or control (Ayobi et al., 2020), while also raising privacy concerns (Thuraisingham et al., 2018).

In professional environments, it is frequent to make data-driven decisions (O'Neal, 2012). For instance, decision support systems support and improve managerial decision-making (Arnott and Pervan, 2008), support teachers' decisions to improve student success in education (Marsh et al., 2006), or help clinicians to improve healthcare delivery using clinical knowledge, patient information, and other health information (Sutton et al., 2020).

In summary, people have been actively collecting and engaging with data as a way to get to know themselves better, either to improve their habits and health or make more informed data-driven decisions in work contexts. These practices suggest a growing literacy and comfort with personal data that could extend to interaction data focused on digital

environments. By accessing and reflecting on their own digital behaviors and interactions, users can gain deeper self-awareness, identify inefficiencies or mismatches, and personalize user interfaces accordingly. This creates a promising opportunity to democratize UI personalization, empowering users not only to tailor interfaces to their needs but to do so through meaningful, self-driven insights.

2.5.1 Discussion

Data can be considered the "*new oil*" of economies and a currency used by customers and companies (Krafft et al., 2021). Interaction data has enabled access to more efficient UIs by informing development teams or through solutions like system-driven personalization. However, while these uses indirectly benefit end-users, they rarely translate into a feeling of empowerment or control (Barkhuus and Dey, 2003; Auxier et al., 2019), with the data subjects (the end-users themselves) perceiving such data practices as posing more risks than benefits (Auxier et al., 2019).

This gap between data collection and user empowerment has led to concepts such as *data-owning democracy* (Fischli, 2024), which envisions a political-economic regime where data is distributed, controlled, and used as capital by citizens. Similarly, the research field of *Human–Data Interaction* (HDI) emphasizes the importance of giving individuals more meaningful ways to engage with their data (Mortier et al., 2014). HDI studies principles such as *legibility* (making data and analytic processes transparent and comprehensible to users), *agency* (empowering individuals to act upon their data), and *negotiability* (enabling them to correct, contest, or redefine how their data is used).

Today, individuals' control and access to personal interaction data are mainly limited to applications or operating systems offering access to screen time data or usage history (e.g., browser history). Consequently, in tools such as personalization software, there remains a need to enhance the transparency of data usage and system decisions (Gajos et al., 2008).

Furthermore, interaction data can support multiple aspects of UI personalization. For instance, Myrhaug and Thomassen (1997) introduced a taxonomy for self-adapting tools that highlights personalization dimensions relevant for systems and users to assess the value of personalized interfaces (Figure 2.7). These dimensions are categorized into three top-level tasks: *evaluate*, *criticize*, and *design*. Each of these can consist of the four generic sub-tasks: *identify*, *confirm*, *generate*, and *select*. We believe interaction data can facilitate various of these tasks, including problem identification and solution evaluation, or enable an informed critique of a personalized UI.

We identify the following gap:

(**GP7**) *Personalization users have not been adequately supported in the decision-*
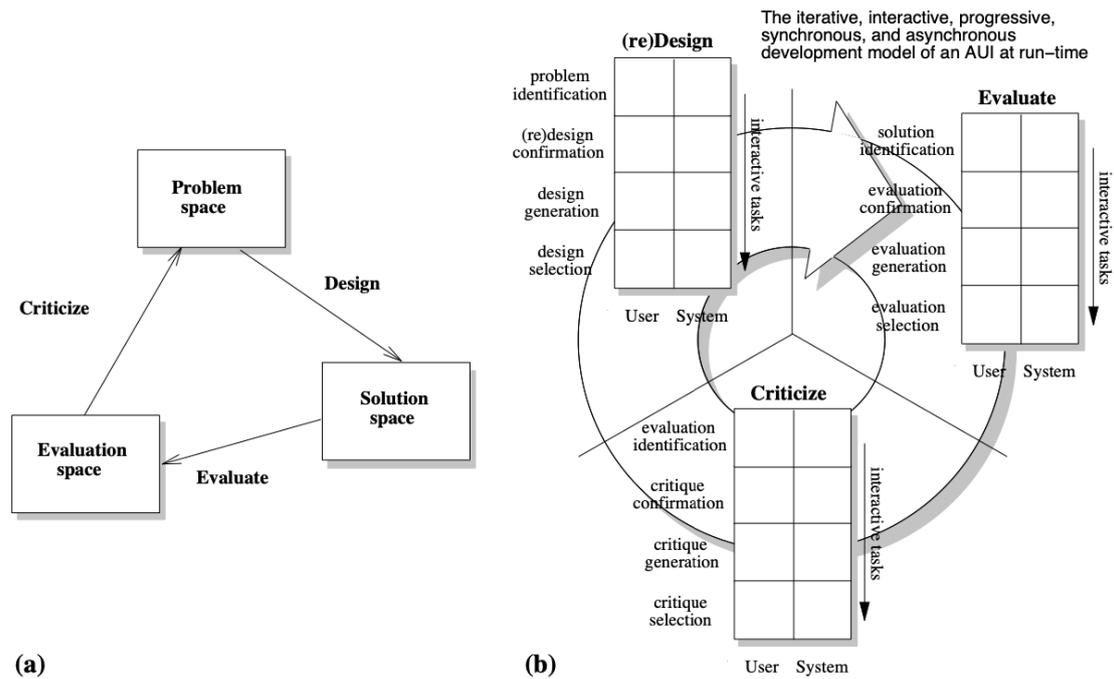
Figure 2.7: A taxonomy for self-adapting interfaces (Myrhaug and Thomassen, 1997). Part (a) presents the base of the taxonomy, which contains three primary tasks (*evaluate*, *criticize*, and *design*) with the three respective spaces: *evaluation space*, *problem space* (the critique space), and *solution space* (the design space). Part (b) expands on this by detailing all the taxonomy dimensions, highlighting the iterative, progressive, and critical aspects of adapting UIs during runtime.

> *making process of UI personalization, particularly in user-driven setups,*
> *including identifying problems, generating solutions, and evaluating their*
> *effectiveness.*

2.6 Summary

This chapter outlined the current state of UI personalization, examined its impact on users' digital experiences with traditional UIs, and highlighted its potential to support the broader goal of UI democratization. Through this analysis, we identified seven key gaps in the literature and existing systems. These gaps shaped and motivated the direction of this dissertation, revealing opportunities to improve the design of personalization systems, particularly to support user agency, inclusivity, and informed decision-making.

UI personalization, in general, poses an attainable alternative or complement to inclusive design paradigms that have been seen as utopian (**GP1**). However, built-in personalization mechanisms still offer limited options, leaving most UI components out of users' control. Ultimately, existing built-in personalization mechanisms are limited to changes developers deem non-disruptive to the UI's original design (**GP2**). This rigidly controlled

model moves away from our vision of UI democratization, which advocates for empowering users. Considering this, there appears to be an opportunity to leverage third-party personalization mechanisms attempting to fix the UIs at runtime.

Third-party UI personalization has been studied for a long time. While users positively received some of the features incorporated in these solutions, most tools remained niche or were eventually discontinued (e.g., Nebeling et al. (2013); Kumar et al. (2011); Bunt et al. (2007a)). For instance, the ability to move and reorder interface elements, features that users appreciated in *CrowdAdapt* (Nebeling et al., 2013), are still unavailable in most current personalization offerings.

While prior studies have effectively examined how users respond to pre-defined personalization mechanisms, they have offered limited room for unforeseen ideas regarding participants' perspectives towards personalization and their needs. Although the personalization concept revolves around giving agency to the individual user, there is a lack of knowledge on what users really want and need to personalize. This is particularly important in a democratization context supported by unrestricted personalization environments, where users are granted greater freedom to adapt interfaces (**GP3**). Additionally, to the best of our knowledge, no existing research has focused on investigating users' current personalization practices (**GP4**). These two gaps are inherently linked: understanding both what people already do and what they desire is relevant for identifying the missing capabilities that users find valuable and expect from future personalization tools.

Considering this dissertation's goal of advancing UI democratization, user-driven personalization, including UI customization, is especially relevant. Unlike system-driven approaches, which often limit user agency by making decisions on behalf of the user and concealing underlying logic, user-driven personalization aligns with the expected values of a UI democratization process, such as empowerment, transparency, and user independence.

However, democratization through user-driven personalization is only possible if the process itself is accessible and supported by tools that empower users to make and implement decisions they confidently know will fulfill their needs. A user-driven personalization process requires physical and cognitive effort, availability, creativity, and often technical skills beyond the reach of most users. To address these constraints, many practitioners have opted to shift control to the system, favoring system-driven or hybrid solutions that offer users limited personalization freedom.

To move toward more accessible and empowering user-driven personalization experiences, we identified two areas in previous research that require attention. First, it is important to reduce the effort required for personalization while keeping users in control of the process and decisions (**GP5** and **GP6**). In this work, we explored, for the first time, the application of community-based concepts to UI personalization, an approach that has proven successful in other domains. In this model, users remain in control of what and

how to personalize, while relying on community support for execution.

Second, users need better support when making personalization decisions. Current user-driven personalization solutions do not assist in identifying beneficial personalization opportunities (**GP7**), a gap that could be addressed by exploring the potential of interaction data. Therefore, it is important to investigate how users can engage with their interaction data for personalization. Equally important is understanding the level of system support needed to ensure that the process empowers users, rather than introducing additional complexity or effort. In this dissertation, we investigate, for the first time (to the best of our knowledge), how interaction data can be integrated into user-driven personalization to help users independently identify opportunities and assess the associated effort and benefits.

In summary, this dissertation contributes to the democratization of user interfaces by exploring how control over UIs and UI personalization can be made more accessible, inclusive, and user-driven. The goal is to broaden who can design, control, and personalize UIs, creating decision-making and UI redesign opportunities for any user.

Through a set of methods that place end-users at the center of research, this dissertation (1) strengthens the understanding of users' personalization needs, strategies, and aspirations; (2) identifies their current personalization practices and the factors influencing personalization adoption; (3) proposes and explores community-based mechanisms to democratize personalization execution; and (4) investigates how interaction data can be integrated into user-driven personalization processes to support the decision-making process. Table 2.2 summarizes the key steps, objectives, and methods of this work.

Table 2.2: Summary of the steps, objectives, and methods of this dissertation.

Step	Objective	Methods
1. Collect personalization needs and preferences.	Strengthen knowledge about users' personalization needs, strategies, and aspirations to inform the design of more inclusive and flexible personalization solutions.	Mixed-methods study involving co-creation workshops, interviews, and focus groups.
2. Identify current practices, motivations, and barriers.	Investigate how users currently personalize UIs and identify factors that enable or hinder personalization adoption.	Semi-structured interviews and a complementary larger-scale survey.
3. Facilitate personalization execution.	Explore community-based mechanisms to reduce the physical and mental effort of implementing and ideating personalization.	In-the-wild deployment followed by user interviews.
4. Support identification of personalization opportunities.	Uncover how a reflexive personalization approach that supports individuals in examining their digital interaction data can help them identify personalization opportunities and reflect on the benefits and effort involved.	Semi-structured interview study employing experimental vignettes as design probes.

Chapter 3

A User-Centric Exploration of Personalization Needs, Practices, and Aspirations

In this dissertation, we place the perspectives of traditional UI users at the center of our research. This chapter addresses the limited understanding of how well current personalization features align with users' preferences and whether, or how, these features are actually being used. Investigating this personalization ecosystem is particularly relevant given that mainstream options often focus on superficial changes (e.g., color modes or font size). Such solutions remain misaligned with richer personalization opportunities that users value when more flexibility is available (e.g., moving or reordering UI elements (Nebeling et al., 2013)) and potentially with others that they may discover in less restrictive personalization environments. Furthermore, when these features are built in, they mainly address aesthetic changes, and even then, they are not as widely available as users would like (Andrew et al., 2024; Ma et al., 2023; Andrew and Tigwell, 2025).

This unmet demand has led to the popularity of third-party personalization tools, which enable personalization beyond what original UIs allow (SimilarWeb, 2022b; dimden.dev, 2025; adlerzei, 2025). Given this context, it was relevant to study the practical needs, current practices, and expectations for UI personalization in general.

To ensure that personalization solutions are meaningful and used in practice, it is also important to go beyond preferences and study the factors influencing people's initial decision to adopt or reject such tools. Even when personalization features are available and offer clear benefits, they can remain unused if people are unaware of them, unconvinced of their value, or hesitant to install them. While it is known that factors such as privacy or the senses of control, agency, and identity (Sundar, 2008; Sundar and Marathe, 2010; Marathe and Sundar, 2011) influence how people engage with personalization, we still lack a clear understanding of how these factors impact users' upfront decisions to install such tools, and how their influence varies across different personalization strategies.

The first step of this dissertation was to listen to users about their everyday in-

teractions with UIs and the role that UI personalization played (and could play) in enhancing their digital experiences, including the context, challenges, and motivations for personalizing. Our goal was to gather a refreshed and user-centered perspective on the role and use of UI personalization in everyday contexts, focusing on identifying unmet personalization needs, the practical use of existing features, and users' aspirations for future personalization solutions. By providing a joint understanding of people's current UI personalization practices and challenges, as well as their preferences and aspirations, the research presented in this chapter aimed to lay the groundwork for developing future personalization solutions more aligned with user expectations. Our research goals (RGs) were as follows:

(RG1) ***Preferences****: Understand how users would like to improve the UIs they use and the associated personalization opportunities.*

(RG2) ***Engagement****: Examine users' context, challenges, and motivations for engaging with personalization.*

(RG3) ***Practices****: Investigate how users utilize existing personalization options, including built-in and third-party features.*

(RG4) ***Aspirations****: Identify and update information on the factors users find critical to install personalization software.*

To address these goals, we conducted two complementary studies. Study 1 was an in-depth qualitative exploration of web personalization on PCs (desktops and laptops), designed to capture, for the first time (to the best of our knowledge), people's personalization preferences in their real-world contexts and to support unrestricted customization. Seven participants (1) recorded in a two-week diary desired UI changes for regularly visited websites, (2) freely customized those websites supported by a researcher, and (3) discussed their experiences in a focus group. This study provided an understanding of personalization preferences (RG1), processes (RG2), and perspectives (RG4).

Study 2 was an online survey (n=145) that examined the prevalence of key Study 1 findings in broader contexts, including mobile devices (smartphones and tablets). The findings that informed the survey design included: (1) interaction challenges such as disorganized and confusing menus (RG1); (2) personalization preferences centered on efficiency and simplicity (RG1); and (3) adoption barriers, including users' tendency to conform to default interfaces, low perceived agency of UI design, and a general unawareness of personalization options (RG2 and RG4). Simultaneously, the survey investigated personalization practices (RG3) and adoption factors (RG4). The protocols for both studies were approved by our university's ethics committee.

In this chapter, we contribute **an in-depth study of personalization needs and preferences (C1), a detailed account of existing personalization practices (C2), and a col-**

lection of the factors impacting UI personalization adoption and its impact across the existing personalization approaches (C3).

3.1 Study 1: Co-creation of Web User Interfaces with End-users

In theory, nearly any aspect of a user interface, from style properties to layout structure, can be personalized. In this study, we aimed to open up this broader perspective to common users. This process was especially important given that prior research (see Chapter 2) has typically engaged people in narrowly scoped studies, often focused on collecting their feedback and perspectives about specific personalization mechanisms. Instead, we aimed to create an open-ended personalization process in which participants' engagement and creative input were not constrained, allowing them to explore personalization beyond a predefined set of options.

Following a multi-method qualitative approach, we combined participant diaries with a co-creation approach to web personalization. We aimed to support people to (1) reflect on areas for improvement in their UIs and (2) personalize UIs freely without restrictions related to their expertise or software features. To facilitate this, a researcher was responsible for implementing the personalization changes, allowing participants to focus entirely on the creative process, with complete freedom to explore unconventional or imaginative personalization ideas.

In this section, we describe the research methods and findings of Study 1, addressing people's personalization preferences (RG1), engagement with personalization (RG2), and perspectives on different personalization approaches (RG4). For clarity, we refer to participants using a study-specific label (e.g., P1.3 refers to participant 3 from Study 1).

3.1.1 Materials and Methods

We conducted a 3-week study where the participants: (1) documented their experiences with web UIs in a diary; (2) collaborated mid-study with a researcher to freely personalize selected UIs; and (3) engaged in a focus group discussion on personalization. This methodology enabled participants to reflect on ways to improve their UIs and the role of UI personalization, both before and after engaging in hands-on personalization.

While phases 1 and 2 focused mainly on web interfaces due to their ease of personalization and platform independence, phase 3 broadened the discussion to personalization in other contexts and devices.

3.1.1.1   Participants and Recruitment

We recruited people with different expertise (in terms of education or profession) and demographic profiles (including age and ability). People interested in participating in our study submitted their intention by completing a recruitment form. We disseminated the study through our local networks and mailing lists and invited individuals who met our inclusion criteria (using the internet for more than four hours per week) to participate. We communicated with participants via phone or video calls, arranging the study sessions based on their convenience.

Table 3.1: Study 1 participant characteristics. HBD = self-reported hours per day spent browsing the internet; DRS = number of diary reports submitted during the study.

ID	Age	Hours Browsing Daily (HBD)	Diary Reports Submitted (DRS)
P1.1	23	12	9
P1.2	28	4	6
P1.3	30	9	8
P1.4	57	5	9
P1.5	66	2	12
P1.6	77	2	4
P1.7	61	2	2

A total of seven participants (P1.1 – P1.7), aged between 23 and 77 years (48.86±21.4 years), completed the study (Table 3.1). Four were men (57%) and three were women (43%). Two other participants withdrew due to difficulties in creating their diaries. Participants usually spend 5.1±3.9 [2 – 12] hours a day browsing the internet. The group included two experts in UI design (P1.1 and P1.3) and one participant who is blind (P1.7); no other disabilities were reported.

3.1.1.2   Apparatus

To support the study, we developed two complementary *Google Chrome* extensions: one for researchers and another for participants. The researchers' tool (Figure 3.1), installed only on the research team's laptop, allowed us to customize the layout of any visited web page. We based the personalization operations on previous work (Nebeling et al., 2013; Bila et al., 2007). The tool enables the research team to hide, resize, move, reorder, change colors, or change font preferences of UI elements. It also supports the manual injection of *CSS* and *JavaScript*, allowing for customization freedom and implementation of unanticipated ideas. A video demonstration of some of the tool's personalization features is available online[1].

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[1]https://youtu.be/lIQ0Hge76_w
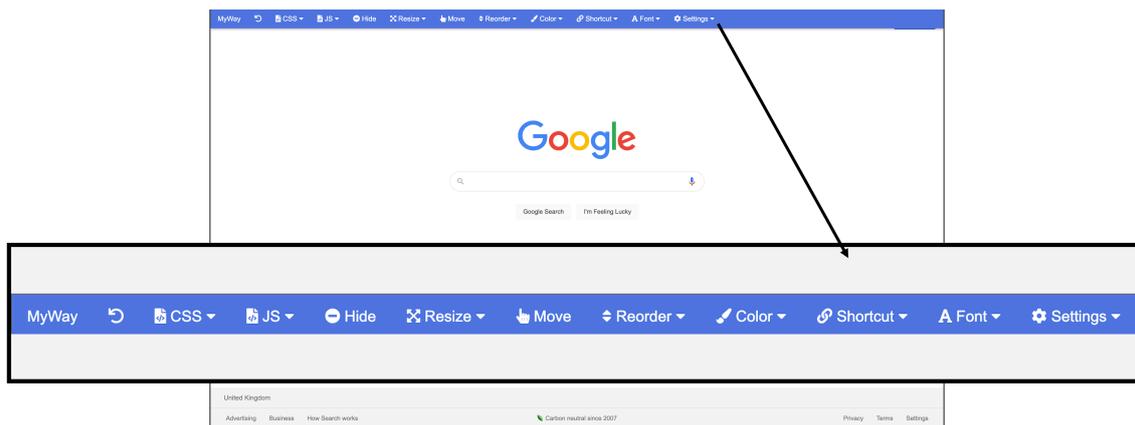
Figure 3.1: The browser extension used by researchers to customize web pages based on participants' directions. It supports predefined operations and the injection of *CSS* and *JS*.

The customization data is stored online, enabling participants to load their personalized UIs with their tool. The participants' tool, available on the *Chrome Web Store*, is straightforward. Participants log in with a personal token and can toggle personalized UI versions on or off via a checkbox for each website customized with the researcher's tool. When enabled, personalized UIs are automatically applied.

3.1.1.3 Procedure

The study began with a 30-minute remote session where a researcher introduced the objectives and obtained informed consent. Following this session, participants engaged in a two-week reflection period: (1) recording their UI experiences in diaries; (2) using these reflections to guide mid-study UI customizations; and (3) continuing diary entries, now with a potentially different perspective on personalization and their agency over UIs. The study concluded with a focus group where participants discussed their evolving perspectives. Additional details are available online[2] and in Appendix A.

Diaries (weeks 1 and 2). Participants documented relevant digital experiences in diary entries while naturally interacting with websites on their personal computers. These experiences included usability issues disrupting their experience, moments of frustration, interface elements they wished to improve, or positive experiences they hoped to replicate. Over two weeks, participants were asked to submit at least one diary entry every three days via an online questionnaire (Appendix A.1).

We encouraged participants to maintain their usual digital routines. The diary served as a record of interface elements that could be personalized in the following study phase (i.e., personalization opportunities). We used this method to help participants better artic-

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[2]https://osf.io/z75xa/?view_only=ff210224f4a147ba9c51079caa671b8d

ulate their needs during the personalization session by encouraging thoughtful reflection in a natural setting beforehand. The participants generated 50 diary reports (Table 3.1).

Exploration of Web Personalization (end of week 1).   Approximately one week after the start of the study, participants had an individual remote personalization session (Appendix A.2), lasting approximately 1 hour and 30 minutes. They collaborated with one researcher on redesigning websites they frequently visited. The personalization process was iterative and collaborative, allowing participants to explore and discuss personalization options while being supported in experimenting with diverse and imaginative solutions. The researcher shared his screen with participants and used the custom-designed tool (Figure 3.1) to personalize on his computer.

Acting as designers, participants proposed improvements based on their diary entries and suggested new design ideas unrelated to their initial reports. We assured them that any personalization was possible. They continued personalizing the websites until they were satisfied and could control the researcher's computer to test their changes.

A screen recording tool captured the audio and the researcher's screen. A pilot session with three volunteers ensured the instrument was functioning correctly.
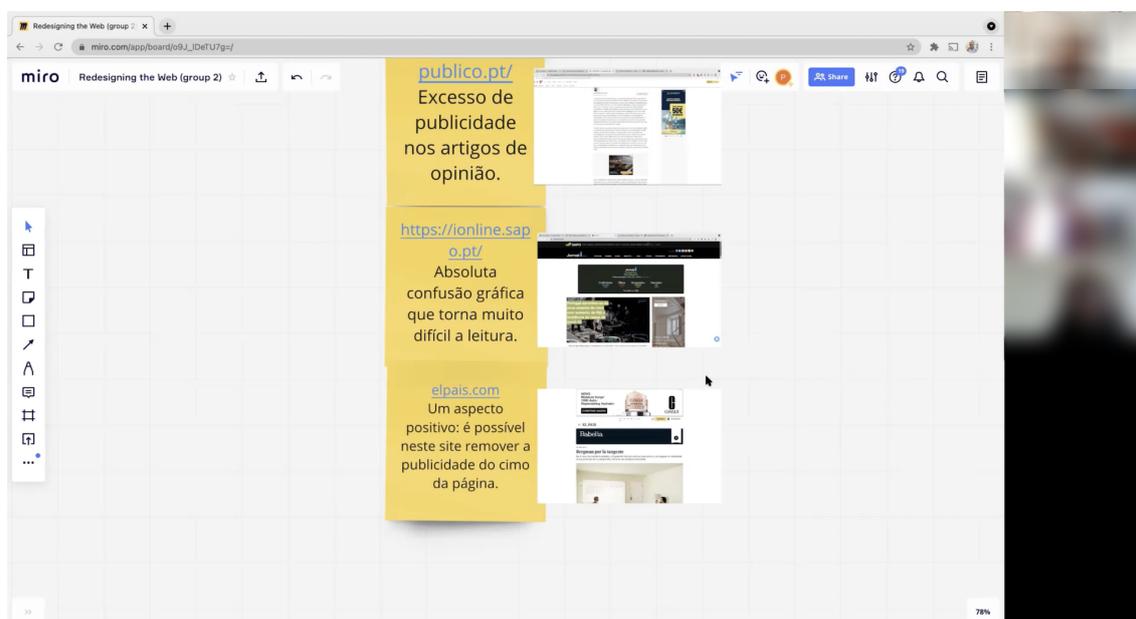
Figure 3.2: A focus group session with three participants discussing diary entries.

Focus group (Week 3).   Participants engaged in a one-hour discussion exploring their experiences with current UIs, personalization preferences, aspirations, and ideas for augmenting UIs, including adaptive or adaptable approaches (Appendix A.3). We selected the discussion topics after reflecting on relevant themes from the previous study phases. We used an online workspace to support the experience with sticky notes and vignettes

addressing the selected topics. We conducted two online focus groups, each with three participants (Figure 3.2). Appendix A.4 presents the workspace of the first group. Due to availability constraints, P1.7 participated in an individual session.

3.1.1.4   Analysis

Two researchers analyzed the transcribed audio and diary reports. We performed a reflexive thematic analysis (Braun and Clarke, 2006, 2019), following the six-phase approach outlined by Braun et al. (2019). The goal was to provide a coherent and compelling interpretation of the data grounded in the collected data. First, two researchers familiarized themselves with the data, taking notes and highlighting important ideas. Then, the researchers inductively and iteratively coded the data. One researcher independently coded six interviews and then met with another researcher, who had coded two interviews, to discuss, refine added codes, and develop candidate themes. The researchers then coded the remaining data. In the following sessions, the researchers approached the coded data with different lenses and created and developed themes. Themes group similar codes together and were organized to provide an insightful story about the data in relation to the research goals.

3.1.2   Findings

In this section, we first summarize participants' engagement with the diary and personalization activities. We then present each relevant theme in dedicated subsections, accompanied by representative quotes that support our findings.

From the total number of 50 diary reports, 26 mentioned exclusively a UI problem (e.g., *"Absolute graphic confusion that makes reading very difficult"* (P1.5)), 13 a problem and a potential solution (e.g.,*"The homepage shows an image that is not relevant. I would like to have access to the current promotions instead"* (P1.1)), and ten exclusively an improvement (e.g., *"I would like to access the shopping cart on the left side of the screen"* (P1.6)).

The websites mentioned in the reports fell into the following categories: 14 were online newspapers, 12 were online retail stores (including groceries, consumables, and electronics), ten were government entities, eight were general information websites, one was a social network, and six belonged to other categories. We discussed all these requests during the personalization session, with 21 resulting in a personalization. Each participant personalized between two and three websites.

3.1.2.1   Personalization Preferences

While each diary report could reflect multiple needs, 26 focused primarily on efficiency, 11 on simplicity, and seven on aesthetics. Below, we present the needs and preferences we

identified on both diary reports and personalization sessions, describing how participants personalized to address them.

Efficiency Preferences.   Participants' primary personalization need was efficiency (**RG1**). They wanted to **minimize the number of interactions** and achieve a more **logical arrangement of elements**. They especially expected increased efficiency from homepages and menus.

Homepages were the primary focus of personalization sessions, reflecting their presence in 27 diary reports. Frustrated with unnecessary clicks and scrolling, participants frequently criticized the current state of UIs, wanting more direct access to relevant items and pages. As P1.6 expressed: "*I always buy the same product (...) and I need to do a series of steps that I could avoid*" (P1.6). P1.1 added, "*The main page is the hub, and there should be more investment in finding ways to help people obtain what they desire from there*".

Participants desire homepages that understand their interests better and present relevant information more effectively. Ideally, homepages should work as users' assistants, as expressed by P1.3: "*I would like the website to help me... to be my right-hand person*". Overall, homepages should adapt to people's interests and help them to decide what to do next.
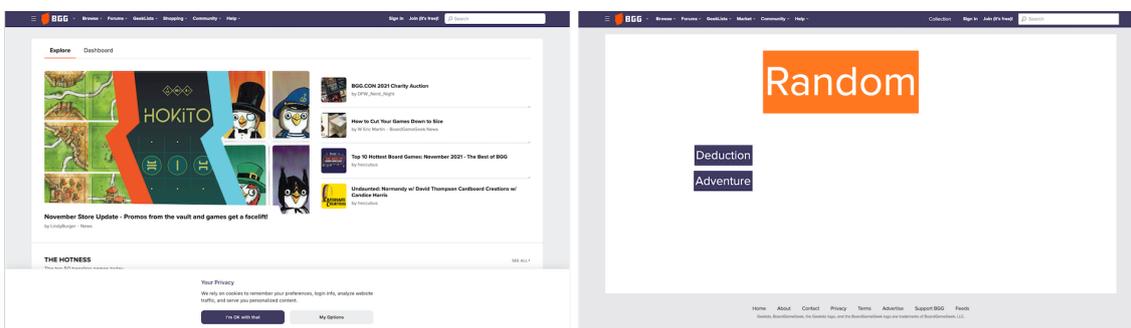
Figure 3.3: Example of an extreme personalization of a popular board games website: the before (left) and after (right).

Figure 3.3 showcases an extreme example of a personalized homepage[3]. P1.1 requested the removal of all unnecessary elements, leaving only two buttons for key features. Participants discussed homepages during the focus groups, with P1.1 commentating that more personalization on homepages would "*encourage exploration of websites*". P1.1 exemplified: "*This [a feature discovered during the session] is a feature that I did not even know existed. If it were on the homepage, I would use it*".

Menus were another key focus of personalization, driven by participants' need for efficiency. As P1.1 noted, "*The menu [of an online store] has no category for board*

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[3]https://boardgamegeek.com

games (...) because of that, I never get what I want in one click". The biggest issues with existing menus are **missing or disorganized categories** and the lack of **adaptation to personal use**. For instance, referring to an online newspaper menu, P1.5 mentioned: "*It does not help me to choose what to read*".

Overall, during the personalization sessions, participants placed high value on efficiency-oriented features, such as adding shortcuts and moving or reordering elements. While the default customization options provided by our tool met most participants' needs, some required additional time and script injection. More complex efficiency needs (some of which we could not implement) included creating new search and reorder filters or linking information between different web sources, for instance, copying data from HTML tables on separate web pages to centralize relevant information within a single interface.

Simplicity Preferences. **Visually confusing** interfaces or **information overload** sparked a demand for **more simplicity** (**RG1**): "*I would say that limiting the websites to the essential, chosen by the person, would be an achievement. It is like a TV remote with many buttons most people do not even understand*" (P1.3).

The ability to hide elements was essential for participants, with their simplicity preferences being particularly evident when "cleaning" homepages and removing reading distractions. **Reading distractions** were a concern, especially in online newspapers. These include every element irrelevant to the reading: unnecessary images, publicity, news suggestions, or even the author. For example, P1.5 noted, "*I can read the author's name better than the article*". This is more evident for the screen reader user (P1.7): "*The personalization of my dreams is to eliminate all information between the headline and the body*".

Aesthetic Comfort Preferences. Although participants prioritized usability, they had minimum quality standards for **aesthetic comfort** in both original and personalized UIs. They wanted their everyday UIs to feel comfortable by increasing "*smoothness*" (P1.4), readability, and visual appeal.

Aesthetic personalizations focused mainly on the text, image size, and colors. Regarding text changes, participants sought to adjust the font size, type, alignment, and line height. Concerns about colors centered on intensity and perceived "*bad taste*" (P1.5). Additionally, participants often requested background color changes but struggled to choose suitable alternatives.

3.1.2.2 Identifying and Ideating Personalization Opportunities

Participants revealed **difficulties in identifying personalization opportunities** (**RG4**), including UI improvements and interaction issues needing resolution. For instance, not all participants complied with the minimum of submitting one diary entry every three days

(Table 3.1). Those who did often expressed uncertainty about the validity and feasibility of their proposed UI changes, and questioned the extent to which the original UI could be modified to support their suggestions (**RG2**). This section explores the reasons behind these challenges and describes how participants identified and conceptualized personalization opportunities.

User Conformity and Self-Adaptation. Participants were **used to existing UIs** or **resigned** with their design, which mainly limited their viewpoint to identify personalization opportunities. When faced with a new interface, they assume that they should adapt themselves to it rather than seeking personalization options, as P1.2 explained, "*With the regular use I am the one who adapts, and it will have to be that way*". Participants expressed overall satisfaction with UIs, as long as the UIs supported them in achieving their goals, even if the process was inefficient. P1.1 noted, "*I usually end up accessing what I want... despite taking a lot longer*".

Furthermore, over time, individuals develop **personal strategies** for interacting with UIs. For instance, P1.7, a screen reader user, pointed out his interaction strategies as his primary concern with personalization and his main challenge when creating diary entries: "*I try to find the best strategy, then I always do the same thing*".

Self-adaptation also influences participants' viewpoints when making design decisions. They often engage in the process of **comparison and draw inspiration from other UIs** that they perceive as well designed and are familiar with. For participants, it was often easier to identify interfaces they enjoy and would like to replicate than conceptualizing a completely new design for an existing UI.

Similarly, participants often **connect UI elements with physical world counterparts**, using "non-digital" common knowledge to inform their design decisions. For instance, P1.4 explained: "*I want the shortcut for this city in yellow [personalizing a weather forecast web page], it is in a typical hot region (...) the capital city can be green [color associated with the city]*".

Sticking With What Works. Participants predominantly interacted with websites they already deemed usable and well-suited to their needs, often avoiding applications or features they perceived as unreliable or inadequate. As P1.3 noted: "*I do not access that feature... I know it does not work*". Since the first phase of the study was conducted in a natural setting, diary entries focused on these familiar, functional UIs. As a result, personalization efforts were naturally directed at interfaces with fewer perceived issues, making it challenging for participants to explore or identify personalization opportunities in those UIs. This also limited participants' ability to consider changes for less familiar or more problematic UIs, which might have benefited more substantially from personalization.

UI Design Unawareness. Less tech-savvy participants often perceived **interfaces as immutable or fixed**, challenging their engagement with personalization and the diaries. They also revealed difficulties in identifying UI elements susceptible to personalization. For instance, P1.4 confessed unawareness of all UI components:

> "*Maybe there are more things [personalization options] I am unaware of. I do not realize the potential. When I look at a UI, I think about the colors or the font, but sometimes there can be other opportunities*".

This challenge was also noticeable in the **vague personalization suggestions** participants made and their difficulties defining alternative values (e.g., colors) for the elements under personalization. Typically, they experimented with different values or expected the researcher to suggest options.

Ultimately, the personalization session increased participants' awareness of UI-related concepts. For instance, P1.4 reflected on her initial difficulty in completing the diary, noting that after the personalization session, she would "*see interfaces from a different perspective*". P1.4 explained that realizing that UIs can be adapted gave her "*a new sense of mental freedom*" and prompted her to be more critical towards UIs.

Personalization Unawareness. Participants also revealed **unawareness of the personalization concept and tools**, which impacted both the diary process and the personalization session. As the personalization session progressed and participants began to understand the potential of personalization, they became more critical of inefficiencies in the UIs they regularly used and started to expect more from them. Consequently, this growing awareness can contribute to improving personalization quality, as illustrated by P1.5's reflection:

> "*If I had from the beginning the notion of what personalization actually is, I could have done it better*"

The research team addressed this lack of awareness during the personalization session by asking elicitation questions or making experimental UI adjustments. For instance, P1.6 showed difficulties reading text but had never asked to customize the font size. When the researcher increased the font size, P1.6 immediately reacted: "*It would be wonderful to have this font size on every website*".

Personalization unawareness was also evident in participants' curiosity about the personalization tool. They were inquisitive regarding its capabilities, questioning or inferring supported operations based on their names.

Expertise and Background. Individual expertise and background influenced most personalization decisions. Experts often attempted to understand the intentions behind the

original design, sometimes rationalizing poor design choices to avoid attributing blame to the designers.

Simultaneously, individual liking and background also shaped participants' reactions to UIs. For instance, P1.3, a product designer, showed concerns with colors and images. On the opposite side, P1.5, a book editor who compares interfaces with books and journals, valued less the images and colors and more the text formatting: "*I would be very interested in improving the reading (...) deep down, similar to a book*".

3.1.2.3   Personalization Perspectives

The difficulties in identifying personalization opportunities highlight more than just user-driven personalization challenges; they underscore how hard it can be for people to grasp the value of personalization. Fortunately, participants do not view these challenges as insurmountable barriers and are open to using personalization mechanisms. Next, we report their perspectives on UI personalization.

Building Personalization Awareness.   The personalization session surprised participants regarding the level of control they could have over UIs and the overall potential of personalization solutions (**RG4**). P1.5 introduced the need to **educate users about personalization**, particularly for ideating design alternatives:

> "*We must be educated about personalization. Sometimes, we do not have enough practice and knowledge to imagine these personalization opportunities. Personalizing is something you learn (...) I believe we have to be made aware of the existing tools, all the tools we are entitled to personalize (...) We get used to the most visited websites, but that does not mean we do not want to personalize them*".

Using a personalization tool can require a mindset change. For instance, P1.7, who revealed fears that personalization could interfere with his current strategies, showed a will to adopt personalization and adapt his mindset: "*If I had a personalization tool to use, I would look at things differently (...) if there were a personalization that surpassed my strategies, I would certainly use it*".

Agency in UI Personalization.   Participants emphasized the need for greater agency in the personalization process. They expressed disappointment with the existing control over content personalization and the expectation of more control over future UI personalization solutions. To address this problem, P1.3 suggested incorporating a "*personalization zone*" in UIs with limited personalization options, providing users with a dedicated space to personalize components freely. Participants highlighted the importance of controlling system-driven personalization decisions, including undoing changes and actively shaping

the algorithm's outputs by selecting the data it considers or providing direct input (e.g., indicating changes in personal preferences).

Privacy.   Privacy was contentious, particularly when discussing system-driven solutions. While some participants were resigned to giving away part of their privacy and enjoyed the benefits of existing content personalization, others were more protective. P1.2 described existing content personalization practices (particularly those based on browsing history) as "*sinister*". To address these concerns, participants agreed on needing an "*on and off*" (P1.3) to control the data collection context. P1.3 mentioned the **trust** in the personalization tool as a critical factor: "*If I had trust in the personalization tool, I would have no problem using it, only benefits*".

Personalization Device and Context.   Participants reflected on how their needs and the perceived value of personalization vary across devices, UIs, and contexts. Opinions diverged between those prioritizing mobile devices, due to limited screen space, and those emphasizing personal computers, especially for work-related use.

3.1.2.4   Summary

This section summarizes the main findings presented of Study 1. Table 3.2 consolidates participants' personalization preferences, their difficulties in identifying and ideating personalization opportunities, and their evolving perspectives on personalization.

3.2   Study 2: Online Survey About Current and Potential Personalization Practices

In the second study of this dissertation, we performed an online survey. Informed by Study 1 deep discussions about UIs and UI personalization, we sought to understand how Study 1 findings expand to a broader and more diverse user sample and context, and collect people's personalization practices.

3.2.1   Materials and Methods

The online survey examined how users with diverse profiles personalize different devices (e.g., mobile and desktop) and UIs. We were particularly interested in understanding (1) if and how people currently personalize UIs (RQ3); (2) their experiences with existing UIs and how they impact personalization (RQ1); (3) their interest in and perceptions of personalization (RQ4); and (4) the factors influencing adoption of different personalization approaches (RQ4).

Table 3.2: Results overview of Study 1.

Personalization Preferences (RG1)

- Participants primarily personalized UIs to improve efficiency.
- They are unhappy with existing homepages and menus, which were their customization focus.
- They favored organizing UI elements (moving, reordering, and removing) and incorporating visual shortcuts to improve efficiency.
- Participants also desired to simplify UIs, as they were concerned with visually confusing interfaces or information overload.

Identifying and Ideating Personalization Opportunities (RG2 and RG4)

- Participants found it challenging to identify interface improvements or problems and ideate alternative designs.
- They conformed to the limitations of existing UIs, adapting their usage instead of seeking personalization options.
- They supported the ideation process by drawing comparisons with other UIs and elements from the physical world.
- Participants struggled with the personalization process due to limited awareness of UI design and personalization.

Personalization Perspectives (RG4)

- Participants were surprised by the control over UIs that personalization enables, highlighting the need to be made aware of it to grasp its opportunities and benefits thoroughly.
- They highlighted the importance of trusting and controlling UI personalization software to feel comfortable adopting it.

3.2.1.1   Participants and Recruitment

The primary recruitment source was *Prolific*[4]. We also shared the survey among our local networks, but *Prolific* has a community of people who perform online tasks and mediate their compensation. *Prolific* was explicitly created to recruit participants for online research and has been found to provide reliable data (Peer et al., 2017). Participants received an average rate of £7.9 per hour, respecting *Prolific* compensation minimums. The survey included two attention-check questions to ensure response validity.

We used *Prolific*'s screening questions to exclusively invite participants who meet our inclusion criteria: being active users of a mobile device and PC (minimum weekly device usage of two hours). We sought a diverse sample by recruiting people of different ages, genders, and ability ranges. To do so, we collected data in multiple stages. We collected the first 25 responses to verify that our instrument worked as intended. Then, we collected the remaining responses by adjusting the screening questions (e.g., age).

The survey received a total of 145 valid responses (P2.1 – P2.145), with 112 collected

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[4]https://www.prolific.co

Table 3.3: Age distribution of Study 2 participants.

Age Interval	Number of Participants
[18, 28]	55
[29, 38]	12
[39, 48]	32
[49, 58]	19
[59, 68]	19
[69, 78]	8

through *Prolific* and 33 through other recruitment sources (Table 3.3). The participants' ages ranged from 18 to 78 (39.9±16.6 years). Seventy-nine were women (54.5%), 64 were men (44.1%), and two preferred not to disclose (1.4%). Participants' age distribution follows the distribution of internet users worldwide (Semrush, 2023). On average, participants reported having 18.6±9.1 [1 – 45] years of PC experience, spending 6.1±3.3 [1 – 16] hours a day using that device; and 9.3±3.7 [1 – 25] years of mobile device experience, spending 4.9±3.1 [0.3 – 16] hours a day using that device.

3.2.1.2   Survey Outline

We divided the survey into four sections: demographics, mobile device, PC, and personalization scenarios. The survey consisted of 86 open-form and closed-form questions covering participants' backgrounds, experience with existing UIs, personalization needs, and personalization practices for mobile devices and PCs. It also presented three personalization scenarios, each accompanied by a representative sketch. These scenarios were designed to capture participants' aspirations to adopt and attitudes toward different types of personalization systems that reflect existing approaches (Chapter 2).

In the *Customization* scenario, users manually adjust the style of all displayed UI elements, similar to *CrowdAdapt* (Nebeling et al., 2013). The *Templates* scenario allows users to select a personalized UI from a set of pre-defined templates, as in *Stylish* (SimilarWeb, 2022b). Finally, the *Recommendation* (mixed-initiative) scenario presents personalization suggestions based on users' characteristics and interaction patterns, which they can accept or reject, similar to *UIFlex* (Proença et al., 2021).

For each scenario, participants rated the expected benefits and usefulness of each system, identified factors that could motivate or discourage them from adopting (i.e., installing) the software, and optionally provided comments. These adoption-related questions combined well-established factors known to influence engagement with personalization (e.g., sense of identity) with insights from Study 1, including challenges in ideation and unawareness of UI design options. This approach allowed us to revisit established factors within the current landscape of digital device use and directly compare them with our early findings, thereby clarifying the relevance of the factors discussed in Study 1 in

shaping personalization adoption.

The survey design was informed by a set of follow-up questions that emerged from Study 1 and align with our broader research goals. Table 3.4 clarifies how we translated these questions into survey components.

Table 3.4: Follow-up questions derived from Study 1 and their influence on the content and structure of the survey in Study 2.

Follow-up Question (Derived from Study 1)	Survey Implementation
To what extent are people resigned to the design of current UIs, and how does this influence their perception of UI personalization (RG2; RG4)?	Questions about how critical or interventionist participants are toward interface design.
Does the broader population exhibit similar perceptions of menu inefficiency and UI complexity as those identified in Study 1 (RG1)?	Questions addressing dissatisfaction with menu structures and UI complexity.
Do people's personalization needs and preferences on a broad scale continue to focus on efficiency and simplicity (RG1)?	Open-form questions addressing frequent interaction challenges, personalization needs, and currently used tools or features.
How aware are users of UI personalization, and how experienced are they in using it (RG3)?	Questions assessing familiarity with mainstream personalization tools, and their past and current use or search for such tools.
Does habituation to original UIs discourage personalization (RG4)?	Scenario-supported questions exploring perspectives on different personalization system approaches, specifically addressing factors such as habituation and reliance on default designs, privacy risks, controllability, or lack of design skills and creative confidence.
To what extent do control and privacy concerns influence people's willingness to install personalization software (RG4)?	
Do difficulties in identifying interaction problems and ideating alternative designs hinder personalization adoption (RG4)?	
Do people approach personalization similarly on PCs and mobile devices, or do their behaviors and expectations differ?	Sections dedicated to each device type, presenting the same set of questions about personalization.

The survey followed a specific order: first, participants could reflect on the problems they may have; then, on what they do to solve those problems or to improve their UIs; and, finally, new solutions.

Likert items were rated on a scale from one to five, with extremes qualified depending on the question (e.g., one being very low and five being very high).

A full version the survey is available online[5] and in Appendix B.1.

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[5]https://osf.io/z75xa/?view_only=ff210224f4a147ba9c51079caa671b8d

3.2.1.3   Analysis

We cleaned up the survey data by excluding responses in which participants failed attention checks, reducing the dataset from 150 to 145 valid responses. We analyzed quantitative data by calculating tables of frequencies for nominal variables and the mean, standard deviation, minimum, and maximum for continuous variables. We also correlated data to understand statistical relationships between specific answers and participants' characteristics (e.g., age or ability); however, we found no substantial differences, excluding this analysis from the reported results.

We analyzed qualitative data using the same method of Study 1. We used the codes and themes developed for Study 1 to code and analyze the data from this study, adding a set of extra codes at this phase.

3.2.2   Findings

In this section, we report the findings of our survey. We start by presenting people's current personalization practices and intentions, disclosing next the opportunities we identified (i.e., existing interaction challenges and personalization preferences) and the factors motivating and challenging personalization adoption.

3.2.2.1   Personalization Practices and Intentions

Most participants revealed to have a **critical attitude** towards the design of the interfaces they use and reported actively personalizing their interfaces, primarily using **default built-in customization features**, such as color modes (**RG3**).

Personalization Profile.   When asked about their level of critical engagement with UI design, most participants reported being moderately critical: 66.7% occasionally consider design improvements but generally accept software as it is. Smaller groups reported being uncritical (12.5%, not questioning UI designs) or actively critical (18.7%, often dissatisfied and reflecting on alternative designs). A small minority (2.8%) identified themselves as highly critical and proactive, modifying UI elements they dislike.

Regarding the extent to which participants modify UIs to suit their preferences, the majority (60%) reported making minor supported changes, such as adjusting backgrounds. Meanwhile, 25.5% indicated making no modifications, using default UIs. A smaller group (13.1%) reported actively seeking tools to personalize UIs, and 1.4% assumed to develop advanced personalization scripts.

Personalization Practices.   We collected participants' use of some mainstream personalization mechanisms (Table 3.5). The most frequent personalization involves changing

background images on both mobile and PC. In contrast, modifying the launcher on mobile devices was the least common personalization action.

Table 3.5: Percentage of participants reporting personalization of different UI elements or usage of mainstream features on mobile devices and PCs (desktops/laptops).

UI Personalization Target or Features	Mobile Devices (%)	Desktop/Laptop Computers (%)
Icons	62	74.5
Wallpaper / Background	93.1	97.2
Font	70.3	69.7
System Colors	N/A	66.2
Color Mode	77.9	64.8
Launcher	24.8	N/A
Ad Blocker	N/A	64.8

Participants' personalization practices and intentions align with their personalization profile, revealing curiosity but limited use beyond the default options.

Notably, **41% of participants revealed to have already searched for applications or tools to adapt their mobile devices and 34% to adapt their PCs**. On mobile, participants primarily focused on modifying the keyboard (n=6) and icons (n=6). Participants want to personalize the keyboard to change its colors or to make it feel more personal, as P2.130 mentioned: "*I did not like to see my keyboard so flat. I felt that personal touch was missing, so I personalize it with photos of my favorite artists*". Participants also use personalization as a means of enjoyment. For instance, regarding icon personalization, P2.88 shared: "*I changed my icons to look like emojis: I thought it was funny and cute*".

In contrast, personalization ambitions on PCs are more limited, with live wallpaper changes (n=5) and adjustments to contrast or brightness (n=4) being the most commonly reported.

Above all, across both platforms, participants who personalize emphasized using the **built-in personalization features** provided by devices or applications (e.g., icon personalization). This option were slightly more prevalent on mobile devices (n=11) than on PCs (n=8).

While many participants reported having searched for personalization tools, **only a small portion indicated having such tools installed, with 10.3% on PCs and 9.6% on mobile devices**. An additional 10.3% had previously installed personalization software on their mobile devices but later uninstalled it. From those, the main reason for uninstalling was switching from *Android* to *iOS* (33%), with participants either satisfied with the new OS design or disappointed by its restrictions on installing personalization software.

Personalization Value Across Devices. In Study 1, the importance of personalization on different devices divided participants. In Study 2, they were asked separately about the importance of controlling UI designs and UI behaviors (i.e., how UIs function or respond to user input). We included this distinction because some reported preferences, such as menu adaptation, depend on behavior.

Most participants valued both dimensions, with a **slight tendency to prioritize personalization on mobile devices**. For mobile devices, 64.1% considered that controlling UI design is important, 62.1% also valued controlling its behavior, 51% valued both, and 6.9% showed no interest in controlling one or another. For PCs, 57.9% considered controlling the design important, 53.8% valued controlling the behavior, 47.6% both, and 17.2% valued none.

Participants also search for personalization tools 7% more on mobile devices compared to PCs, although the reported number of tools installed on both devices is similar.

3.2.2.2 Personalization Needs and Opportunities

This section provides a general perspective on the impact of common UI concerns, followed by an analysis of reported personalization needs and gaps.

Table 3.6: The frequency of common UI concerns reported in Study 1 (1–5 scale, 5 = most frequent).

Device	Disorganized menus	Excess of information	Excess of features	Not adapted to interests
Mobile	2.8	3	3.1	3
PC	2.7	3.2	3.1	2.9

Perspectives on Existing UIs. To investigate how the UI concerns identified in Study 1 generalize to a broader population, we asked participants how often they encounter disorganized menus, interfaces with excessive information or features, or not adapted to their interests. Results indicate that these issues exist but are not encountered frequently (Table 3.6).

Table 3.7: Participants' opinions about UI elements (1–5 scale, 5 = totally adequate).

Device	Font size	Images size	Buttons size	Contrast
Mobile	4	4	3.7	4.1
PC	4.2	4.3	4.3	4.2

Participants also reported their experience with common UI elements, expressing general satisfaction with font size, image size, and general contrast, while button size raised

the most concerns, especially on mobile devices (Table 3.7).

Personalization Needs. Despite the general optimistic perspectives on existing UIs, people show interest in personalizing them when in the proper context and with a clear understanding of their goals and needs.

Participants shared examples of UI changes they would like to make in an optional open-form question. The answers reinforce findings from Study 1, highlighting a **strong interest in personalization aimed at improving efficiency** (**RG1**). Notably, participants mentioned **menus** even more frequently than in Study 1. Thirteen participants reported menu-related personalization intentions on mobile devices and seven on PCs. The most reported concerns were menus with missing categories, unexpected organization, or non-descriptive item labels. Participants desired menus that are "*more intuitive*" (P2.77) and "*easier to find and use*" (P2.30). To do so, they wanted to remove and reorder menu items, or use adaptive menus with "*quick access to the most used menu options*" (P2.122).

Reorganizing folders, icons, list items, and UI elements in general was the priority for other participants, both on mobile devices (n=9) and PCs (n=4). Organizing UIs was often linked to efficiency, as participants aimed to place UI elements in more accessible (e.g., closer to the top) or logically arranged locations. Buttons (n=9) were especially emphasized (e.g., "*standardize sign-out button positions*" (P2.32)), while participants also wanted to reorder or filter list and table elements.

Beyond UI organization, incorporating **shortcut buttons** for quicker access to key actions is also valued for increasing efficiency, both on mobile devices (n=6) and PC (n=4). For instance, P2.22 highlighted the intention to "*add ways to get where you want to go*".

Accessibility related personalization, particularly for improving **reading ease**, was a key focus for many participants (n=11). The most desired UI changes included increasing font, image, button, and keyboard sizes, as well as adjusting colors, contrast, and incorporating color-blind modes.

Improving UIs **aesthetics** was also valued (n=9), with participants mainly interested in adjusting colors, icons, font types, or creating custom color modes. These changes were often driven by a desire for uniqueness and self-expression, as P2.25 demonstrated:"*I would personalize websites themes... to add my personal touch*".

Simplicity-related needs, although often inherent to organization and accessibility needs, had a lower presence in Study 2 relative to Study 1. These needs primarily focused on reducing information overload (n=4), as P2.71 exemplified: "*Sometimes it feels like the developers add everything possible, some of which may not be necessary for all of us*".

3.2.2.3 Factors Motivating Personalization Adoption

Participants selected multiple factors that would motivate them to install the systems described in the three personalization scenarios, with the option to provide open-form answers. *Efficiency* was the primary motivator in the *Customization* (mentioned by 55% of participants) and *Recommendation* (51%) scenarios, while *curiosity* (51%) was the most cited for *Templates* (Table 3.8).

Analyzing the influence of factors across scenarios, *sense of control* (45%) and *sense of identity* (37%) stand out in *Customization* and *accessibility* (31%) in *Recommendation*. Conversely, *sense of identity* (20%) and *sense of control* (21.4%) have less impact in *Recommendation*.

Table 3.8: Factors motivating the adoption of different personalization approaches. The table presents the percentage of participants who identified each factor as a motivation for installing a given personalization software.

Motivating Factor	Customization (%)	Templates (%)	Recommendation (%)
Efficiency	**55**	47	**51**
Curiosity	50	**51**	33
Sense of control	45	37	21
Fun	41	36	21
Sense of identity	37	30	20
Accessibility	29	27	31
Dissatisfaction with UIs	31	35	17
Saturation of UIs	22	29	12
Invitation from a friend (social pressure)	8	9	10
None of these	3	6	1

These results confirm that **people are primarily motivated to adopt a personalization tool in search of *efficiency***. Additionally, *curiosity* indicates that people are open to exploring personalization, even without a clear motivation. Few participants (1–6%) reported no motivation for any factor, suggesting a general interest in personalization across scenarios.

The *sense of control* and the *sense of identity* are particularly motivators in the *Customization* scenario, but played a less significant role in the *Recommendation* scenario. P2.130 articulated the value of expressing identity through personalization: "*We should feel that we are part of the applications we use, that they belong to us. That way, the experience becomes much more intimate*".

We also asked participants to rate how likely they were to use each system (1 = not likely, 5 = very likely) and how beneficial they perceived them (1 = not beneficial, 5 =

very beneficial). The majority (87.6%) indicated they would likely use at least one system (>3), with average ratings of 3.6 for *Customization* and *Templates*, and 3.2 for *Recommendation*. Regarding perceived benefit, 84.8% rated at least one system as beneficial, with averages of 3.7 for *Customization* and 3.6 for *Templates* and *Recommendation*. In summary, **participants are willing to use at least one of the described systems**. None stands out positively, but people are less likely to use the *Recommendation* system, despite being considered as beneficial as the others.

3.2.2.4 Challenges to Personalization Adoption

Participants identified multiple factors that could deter them from installing the systems described in the personalization scenarios (Table 3.9). The most mentioned factors were *lack of time* (41%) for *Customization*, *satisfaction with the existing UI* (34%) for *Templates*, and *privacy* (39%) for *Recommendation*. Next, we delve into the most significant challenges, incorporating findings from open-form responses.

Table 3.9: Factors challenging the adoption of different personalization approaches. The table displays the percentage of participants who identified each factor as a challenge for installing a given personalization software.

Preventive Factor	Customization (%)	Templates (%)	Recommendation (%)
Satisfaction with existing UI	35	**34**	25
Lack of time	**41**	**32**	19
Privacy concerns	29	22	**39**
Habituation to the existing UI	33	**32**	23
Complexity	34	28	20
Lack of interest	26	26	17
Lack of programming skills	28	22	15
Lack of design skills	22	18	14
Reliance on the original design decisions	14	8	16
Lack of utility	12	10	6
Difficulties imagining design alternatives	15	11	11
None of these	2	0	0

Workload. Time and effort are key considerations in personalization, with some avoiding personalizing due to the "*anticipated amount of work to get things done*" (P2.12).

For some (n=2), personalization effort led to uninstalling personalization software: "*I installed some tools in the past, but the amount of work overtakes gains for me*" (P2.125).

Across the scenarios, *lack of time* particularly impacts *Customization*. Many participants preferred *Templates* for its ease: "*I like the idea of a limited number of options; each presumably well-designed to suit users. It is less daunting and time-consuming*" (P2.93). However, some favored UI control over easiness: "*Templates may not fit my needs exactly. I prefer tools that allow me to adjust every layout aspect to my needs, even if it takes some time initially*" (P2.30).

Privacy and Data Security.   Several participants (n=9) cited **privacy and data security** as the primary reason for never having installed a personalization tool. As P2.107 explained: "*I have never downloaded personalization software because I am unsure which ones to trust and are safe*". These concerns also contribute to participants' preference for relying on built-in personalization features (Section 3.2.2.1).

Privacy concerns were particularly expressed in the *Recommendation* scenario (n=7). Participants emphasized that personalization "*should work without giving the impression of being monitored*" (P2.34) and expressed fears that it "*could become a gateway for selling personal data*" (P2.20) or "*violate*" (P2.64) their identity.

Privacy is outstandingly the challenge with the highest impact in a personalization scenario (Table 3.9). For example, while *lack of time* is the most common challenge for *Customization*, it represents only 23% of the responses, whereas *privacy* dominates *Recommendation* with 35%.

Habituation.   Habituation to existing UIs is one of the top factors preventing personalization adoption across all three scenarios, reinforcing Study 1 findings on conformity (Section 3.1.2.2). However, it does not seem to be the most decisive factor or even a barrier, with few participants (n=3) mentioning it. P2.51 was an exception: "*I learn how to get what I want from an application over time. Therefore, I might not want to personalize*".

Fear of Losing Control in Personalization.   Participants expressed concerns about losing control over and for personalization, fearing both extremes of control. With detailed control, they worried about making **irreversible changes**, accidentally making transformative changes that disrupt the layout, or hiding elements they may need later. In contrast, in scenarios like the *Recommendation*, they reported a **fear of losing control**: "*It is a bit scary when the system anticipates my needs*" (P2.34); "*I do not like being out of control*" (P2.92).

Despite the importance of controlling the personalization process, the guidance offered by the *Recommendation* system was for some participants positive: "*It is the most*

practical and beneficial scenario because I will be able to make the changes guided by the program, avoiding errors" (P2.107). Overall, opinions were contradictory, and the best solution can be a combination of scenarios: "*A combination of Customization and Templates might be the best. To have the option of selecting UIs or re-arranging them from scratch*" (P2.80).

General Personalization Challenges.   While the previous challenges exert varying degrees of influence on each personalization approach, two overarching challenges impact personalization adoption overall, particularly for third-party solutions.

First, most participants (59%) had never searched for personalization tools. Beyond those who simply lacked interest (13 on mobile, 11 on PC), the most cited reason was the **unawareness of personalization tools and where to find them** (14 on mobile, 11 on PC). This challenge closely mirrors the unawareness of UIs and personalization identified in Study 1. P2.25 is an example: "*I do not have any tool installed because I was unaware that you could download them and I would not know which are the best/most useful*". Some participants even expressed a desire for features that already exist (e.g., smartphone icon customization), underscoring their unawareness of personalization options.

Second, while participants' use of built-in personalization features is a promising result (Section 3.2.2.1), they showed **hesitation to personalize beyond built-in options**. This reluctance appears to stem from previously discussed challenges, including privacy concerns about third-party tools (e.g., "*Probably suspicious of applications in general. Apple seems to want me to be wary of non-apple applications*" (P2.38)), satisfaction with the built-in options (e.g., "*I find everything I need in my smartphone software*" (P2.98)), or the perceived additional effort to personalize. Additionally, some participants (n=2) mentioned a preference for limiting personalization to the initial setup of devices or applications, reducing their interest in third-party solutions: "*I just do not care enough outside the first setup. I go through settings, change important things, and turn off everything else*" (P2.37).

3.2.2.5   Summary

Table 3.10 summarizes the key findings of Study 2.

3.3   Discussion

In this chapter, we studied personalization from a general perspective, considering different categories of devices, UIs, and personalization solutions. We first performed a co-creation study, where people reflected on how to improve the UIs they use and personalized them. Participants personalized freely and for the first time, to the best of our

Table 3.10: Results overview of Study 2.

Personalization Practices and Intentions (RG3)
• Although people may conform to the limitations of existing UIs (Study 1), most expressed a runtime desire to adjust the UIs they use.
• Individuals' personalization awareness and experience are often limited to simple adjustments (e.g., background), complementing Study 1 findings.
• People actively use built-in personalization features included in mainstream software.
• People seek third-party personalization tools; however, few are currently using one.
• Installed third-party personalization tools primarily focus on the keyboard, icons, and wallpaper.
• Participants expressed a slightly higher interest in personalizing mobile devices compared to PCs.
Personalization Needs and Opportunities (RG1)
• People face UI problems like excess information or features (Study 1 findings) but not with extreme frequency.
• Most people envision personalization as a way to reduce complexity and streamline the steps required to achieve their objectives within UIs.
• Reorganizing UIs, particularly menus, shortcuts, and icons, is highly desired, confirming Study 1 findings.
• People also value personalizing to enhance accessibility and aesthetic.
Factors Motivating Personalization Adoption (RG4)
• Seeking efficiency is the primary motivation to personalize, reinforcing Study 1 findings.
• People are curious to personalize and expect pleasure from controlling their UIs or expressing their identity.
• People enjoy the control provided by customization and the agility and guidance provided by mixed-initiative mechanisms.
Challenges to Personalization Adoption (RG4)
• Habituation and satisfaction with existing UIs are challenges transversal to all personalization approaches (confirming Study 1 findings); however, most people still do not perceive them as barriers to using personalization software.
• People do not expect the lack of design or programming skills and ideation challenges (two factors emerging from Study 1) to hinder personalization adoption.
• Lack of time is the main obstacle to customization.
• Privacy is the main barrier to adopting adaptation and mixed-initiative strategies.
• People who do not use third-party personalization software are either unaware of its existence or reluctant to personalize beyond the built-in options available.

knowledge, without constraints related to their technical skills or the software. We gained valuable insights into their personalization preferences or expectations.

We then conducted a survey to investigate further personalization usage, preferences, and factors impacting adoption. We identified, for the first time, people's current per-

sonalization practices and studied challenges, motivation boosters, and needs relevant to future research. This section discusses what we learned according to each research goal.

3.3.1　Personalization Preferences and Opportunities (RG1)

People primarily aim to personalize to enhance efficiency, reducing UIs complexity and streamlining interactions. Their main personalization targets are homepages and menus, revealing intentions of improving UI organization by incorporating visual shortcuts and moving, reordering, and removing elements (Study 1). The ability to simplify interfaces is also highly valued, as people are concerned with visual clutter and information overload. Study 2 reinforced these findings for different devices and UI environments, revealing that most people see personalization as a way to improve their workflows and prioritize reorganizing menus, shortcuts, and icons. They also value changing font, text, and color properties to increase text readability and overall accessibility.

Some personalization needs can be met with simple pre-defined or parameterized operations where users directly apply styles to elements (e.g., hide, move). However, many involve varying degrees of complexity, such as analyzing browsing behavior for adaptive menus, using macros (Borodin, 2008) or trigger-action programs to streamline workflows (Ur et al., 2016), or performing automatic role detection of visual elements for UI standardization (Duarte et al., 2018). Additional complex needs may require the involvement of software developers (e.g., linking data from different sources), interaction with Web APIs, or sophisticated client-side scripting.

This diversity and complexity of people's preferences highlight the need for improved personalization mechanisms. Built-in features fail to provide the level of freedom and control users seek, while third-party solutions (SimilarWeb, 2022b; Biniok, 2022) typically rely on code injection, neglecting non-expert users. Additionally, user-driven solutions may require effort and skills out of users' scope, and system-driven solutions can struggle to anticipate the nuances and evolution of these diverse needs (Stuerzlinger et al., 2006; Coutaz, 2010), creating an opportunity for more balanced approaches.

One such approach involves expanding **crowd-based personalization** (Nebeling et al., 2013). We identified two personalization stakeholders: those who desire complete control over their UI and have availability, perception about UIs, and skills to personalize, and those who prefer not to engage in additional work or overthink possible personalizations. Crowd-based components could connect these groups, enabling skilled users to assist others by writing scripts or contributing to ideation.

Additionally, following **human-machine collaboration** principles, conversational agents like *ChatGPT*[6] could help implement complex personalizations by facilitating reflection, ideation, and implementation through dialogue. A collaborative approach, where users articulate their needs, and the system personalizes accordingly, could provide a

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[6]https://chat.openai.com

sense of control without manual manipulation. Furthermore, users could bypass decisions related to design details that they find challenging. This idea builds on prior work showing that *ChatGPT* can assist design thinkers, such as by helping to formulate and solve design challenges (Fischer et al., 2023), and automate the creation of *HTML* and *CSS* code (Patel et al., 2025).

3.3.2 Identifying Personalization Opportunities and Engaging in Personalization (RG2)

People have difficulties identifying opportunities for improving their UIs and ideating personalization solutions. They become accustomed to existing UIs and, over time, adapt their interaction strategies and expectations, rather than seeking personalization options. Study 2 revealed that while most people occasionally wish they could change the UIs they use, this often does not result in personalization. **People are critical of UIs but unaccustomed to taking control over them**. This reinforces Study 1 findings that personalization, especially identifying problems and solutions, requires a mental exercise that users are not familiar with and must gradually develop skills and awareness for.

Ideation challenges can affect all personalization approaches, as individuals who struggle to see UIs as mutable or imagine improvements may not recognize personalization as valuable or necessary. Kim et al. (2022) showed that people make vague and abstract personalization requests, lacking details. We found that ideation challenges go beyond that, starting with how people perceive UIs and identify opportunities for improvement. Specifically, non-experts often view UIs as fixed and are skeptical about the feasibility of implementing their desired changes.

Our results suggest that **people need guidance to identify opportunities for improving their UIs or UI problems**, something they can do after a discussion and reflection. For instance, people expressed general satisfaction with UIs (Table 3.6) but sometimes contradicted themselves in later statements. In that sense, personalization suggestions (such as in the *Recommendation* scenario) can play a guidance role, introducing personalization operations or inefficiencies users may be unaware of. However, we found that these approaches introduce privacy concerns similar to those observed in fully automated solutions (Jameson, 2007). A possible solution could be the human-machine collaboration discussed earlier, where users receive guidance without providing personal data.

Two alternative approaches to facilitate ideation and implementation are experimentation and example-based personalization. **Experimentation** allows users to test different properties and styles (e.g., font types) or explore entire UI variations, similar to the *Templates* scenario. Additionally, Study 1 revealed that users often seek to replicate well-designed UIs, suggesting that **example-based personalization** (Kumar et al., 2011) could further support ideation.

Personalization is also shaped by when and how users engage with it. Häkkilä and

Chatfield (2006) found that most mobile phone personalizations occur within the first week of use. Our findings suggest **personalization should be supported across different stages**. Some participants primarily personalize during the initial setup of devices and applications. Providing built-in personalization mechanisms during onboarding could contribute to personalization adoption by (1) leveraging users natural personalization lifecycle, (2) increasing their exposure to personalization, and (3) providing opportunities to personalize before habituation and development of personal strategies. However, users may be unlikely to revisit settings to personalize later.

On the other hand, personalization aimed at improving efficiency benefits from users' reflections at later stages. We assume that during onboarding, people base their personalization choices on preconceived preferences (driven by personal likings), which can suit aesthetics-related personalization. Efficiency-related personalization requires a deeper understanding of the UI, context, and interaction patterns that users develop over time. We found that individuals go through a self-learning process and develop interaction strategies, which could lead to more informed personalization decisions. Future work should study when and how to prompt users to personalize or reflect on improving their experience. A potential approach can follow the example of multi-layer interface design (Shneiderman, 2002), where users start with simple changes (e.g., selecting a color mode) and gradually progress to higher layers of informed decisions, like menu personalization.

3.3.3 Current Personalization Practices (RG3)

We found that **people primarily personalize using built-in software options but rarely go beyond them**. Encouragingly, 41% of participants sought third-party personalization software, revealing an interest in expanding their personalization options, yet only 10% currently use one. The rest had never considered external personalization tools, often due to a lack of awareness or privacy concerns. This behavior creates a dichotomy: **most personalization needs cannot be met with existing built-in options, yet people lack trust and awareness of third-party solutions**.

This misalignment is particularly relevant considering people's preferences. While built-in personalization features often focus on aesthetics and accessibility, our findings reveal that people primarily want more options centered on efficiency. This suggests that the existing options can meet most aesthetics and accessibility needs. Similarly, this expectation for more options focused on efficiency may result from the lack of built-in options for improving efficiency, organization, or simplicity. This highlights the importance of expanding built-in personalization options, especially for those reluctant to install third-party software.

Interestingly, people also use third-party software primarily for aesthetic personalization, such as modifying icons, widgets, keyboards, and wallpapers. This could suggest that efficiency-related personalization tools are perceived as more complex or less trust-

worthy, especially since most require technical skills beyond the reach of typical users.

Beyond trust, the adoption of third-party personalization software is also challenged by its limited **discoverability**. In Study 1, participants showed a general unawareness of their personalization options, with non-experts, in particular, expressing surprise at the potential of personalization, especially the level of control it offers over UIs. In Study 2, we found that among the 59% of participants who never sought personalization software, there was a significant lack of awareness of personalization concepts and tools. Future work must address the challenge of making personalization tools discoverable. This issue is also observed in other research fields, with people revealing a lack of awareness of accessibility software (Trewin, 2000).

Ultimately, the discoverability challenge can also affect built-in personalization. For instance, even when accessibility settings are available within operating systems, users lack awareness of their existence (Heron et al., 2013b; Wu et al., 2021; Vanderheiden et al., 2020). Companies often conceal personalization solutions within the umbrella of accessibility (Raising the Floor, 2022; accessiBe Inc., 2022), leaving users unaware of their existence. This may mislead potential personalization users who are not seeking accessibility settings. Companies should embrace personalization as a concept independent of accessibility and introduce the available features to users.

3.3.4   Critical Factors for Personalization Adoption (RG4)

Study 1 revealed some factors that could hinder personalization adoption, including limited awareness of personalization and UI design, users' adaptation to UIs over time, and difficulties in identifying and ideating personalization solutions. Additionally, the importance of controllability and privacy, two well-known factors (Jameson, 2007), were particularly highlighted by participants. Despite these challenges, they expressed a clear **desire for more personalization options and to gradually learn how to leverage them**.

In Study 2, we studied how the factors identified in Study 1 influence personalization adoption using a scenario-based setup. Simultaneously, prior work has highlighted factors such as sense of identity, sense of control (Marathe and Sundar, 2011; Sundar and Marathe, 2010), and social influence (Banovic et al., 2012) as shaping how people engage with personalization. However, it remained unclear whether the importance of these factors extends to personalization adoption. To address this, we compared the emerging factors from Study 1 with those previously established in the literature, exploring how they can impact adoption across different approaches.

Overall, most people (> 80%) are willing to use personalization software and expect benefits from it on both mobile devices and PCs. Their motivation to personalize relates to the reported individual needs. They are mainly motivated to personalize to improve efficiency. Other than that, they are curious to adopt customization and template solutions and expect pleasure from controlling their UIs or expressing their identity. The senses

of identity and control are indeed strong enough to motivate customization adoption. Interestingly, despite the necessary customization effort, people expect the process to be fun. On the opposite side, the value of adaptation mechanisms concentrates on increasing efficiency.

On the downside, the adoption of adaptation software faces privacy concerns, while customization is challenged by time and effort, two well-documented challenges (Jameson, 2007; Mackay, 1991). Our work advances this understanding by quantifying their expected impact, revealing privacy and effort as the key barriers to adopting these approaches. Factors identified in Study 1, such as habituation and satisfaction with UIs, can pose challenges to adopting more controllable forms of personalization, unlike ideation difficulties, which have limited impact.

Mitigating these negative factors can be particularly challenging: customization strategies must reduce effort while providing the desired personalization freedom and control; and adaptation solutions must reduce privacy concerns while still collecting browsing data. We advocate that these personalization mechanisms should demonstrate personalization benefits. **People should be made aware that investing a portion of their privacy and personal time is worthwhile**. For example, future work can explore making personal interaction data visualizations accessible to users, to highlight inefficiencies in interaction patterns, helping users recognize when personalization is worth the effort (Mackay, 1991), support the ideation process, or improve the transparency and rationale of personalization recommendations (Bunt et al., 2009).

3.3.5   Study Limitations

In Study 1, participants focused on the websites they frequently used, which they naturally had previously deemed usable. A longer study duration could have allowed for exploring personalization possibilities beyond familiar UIs. Additionally, no personalization session was dedicated to addressing the diary reports from the second week. This may have reduced participants' engagement in submitting diary entries during that period.

Study 2 participants, recruited through online channels, may, on average, possess higher levels of technological familiarity than the general user population. Although the sample may not be representative of the broader population, we believe the findings offer valuable insight into future personalization trends.

3.4   Summary

In a co-creation study (n=7) and an online survey (n=145), we explored people's personalization practices, preferences, perceptions, and aspirations. We found that people personalize actively using built-in personalization features. However, they are unfamiliar with third-party personalization tools or reluctant to personalize beyond the built-in offer,

which does not cover people's main need: efficiency. While personalizing, people were excited to see how their UIs could be adapted and disappointed when they realized the limited control they currently have over UIs.

This chapter provides recommendations for researchers and developers to progress toward increasing people's experience with UIs. To increase people's engagement with personalization, research should go beyond simply meeting their personalization preferences. Particularly, ideation is a significant general personalization challenge.

Future personalization research should study how to assist users in the creative process, support the different personalization needs, and take advantage of the impact factors to increase personalization efficiency and adoption.

Chapter 4

A Community-Based Approach to Democratizing Personalization

In the previous chapter, we found that people prefer controllable forms of personalization, such as UI customization, and that their personalization needs can be highly diverse and complex. Addressing these needs often requires technical skills, time, and effort beyond what most users can manage (Mackay, 1991). This is evident in the existing customization solutions that offer fine-grained control (Biniok, 2022; SimilarWeb, 2022b), which typically require coding. Such requirements may make tech-savvy users feel comfortable with customization, while less tech-savvy users hold negative attitudes (Sundar and Marathe, 2010). Furthermore, even among tech-savvy users, some complex challenges can require more knowledge than a single individual possesses (Paternò, 2013).

To truly empower everyday users in shaping their digital experiences and advancing the democratization of user interfaces, it is essential to make the personalization process itself more accessible and inclusive. In particular, meaningful customization should not be limited to experts, whether due to the technical complexity of methods like code injection or the difficulty of reimagining design alternatives.

As a path to democratization, we propose a community-based approach, where people can personalize interfaces themselves, seek assistance from others, or share reusable personalization templates. Collaboration can not only make personalization more accessible but also contribute to collective intelligence, where shared knowledge strengthens the community and its members.

In this chapter, we first explore the dynamics of community-based UI personalization, studying how users personalize interfaces for themselves, assist others, or request personalization assistance. We introduce the concept of customization assistance requests, in which, given a request, a personalization user can customize interfaces for others. This exploration was a first step toward understanding the motivations behind assisting others or seeking help, which are key dynamics in a community-based personalization approach. We defined the following research questions:

(RQ1) *How do people independently use a customization tool to customize for the self, including context, challenges, and motivations?*

(RQ2) *How do they make use of the chance to request customization assistance?*

(RQ3) *How do they react to possibly supporting others to customize?*
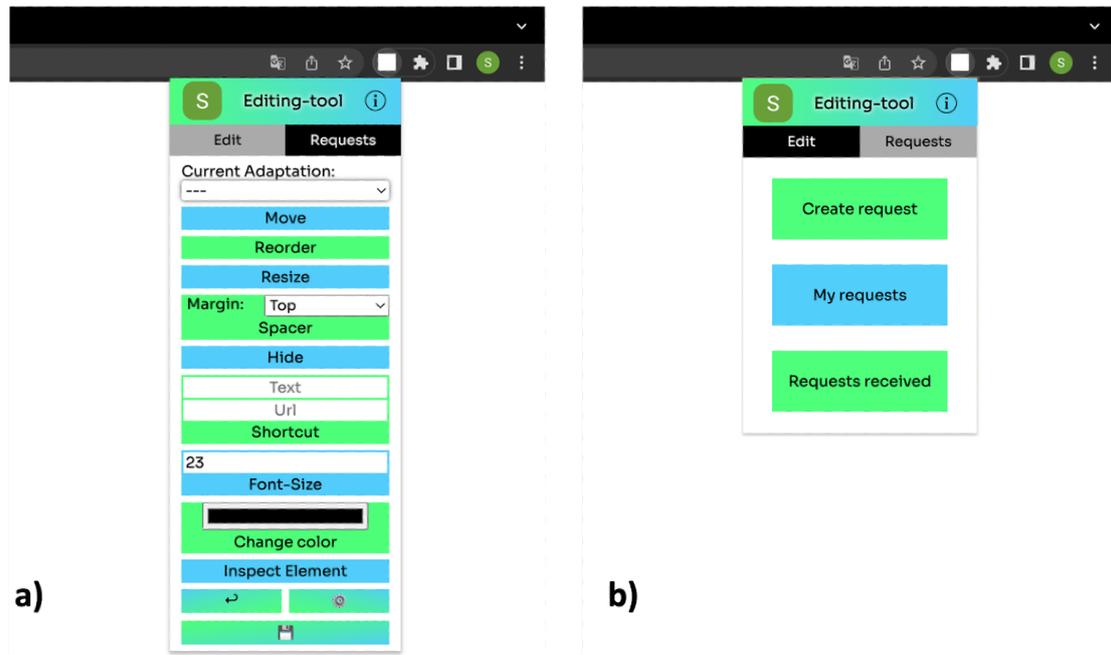
Figure 4.1: The *GitUI* extension allows users to (a) customize with nine operations, and (b) manage and create customization requests.

To address these questions, we performed an exploratory study in which nine participants, both experts and non-experts, used *GitUI* (Figure 4.1) for two weeks. They used the tool to freely customize interfaces, as well as to create and respond to customization assistance requests from the crowd.

Building on this study, we then propose the novel concept of community-based UI personalization, aimed at democratizing access to customization and personalized UIs. We believe this approach can extend the benefits of a user-driven and unrestricted personalization setup to common citizens, who may lack the time or expertise to personalize or repair the UIs they use.

In this chapter, we contribute **an analysis of the dynamics of a personalization assistance apparatus and the community-based personalization concept (C4)**.

4.1   Methods

We performed a two-week exploratory study where participants used *GitUI*. The study followed all ethical considerations required by our university.
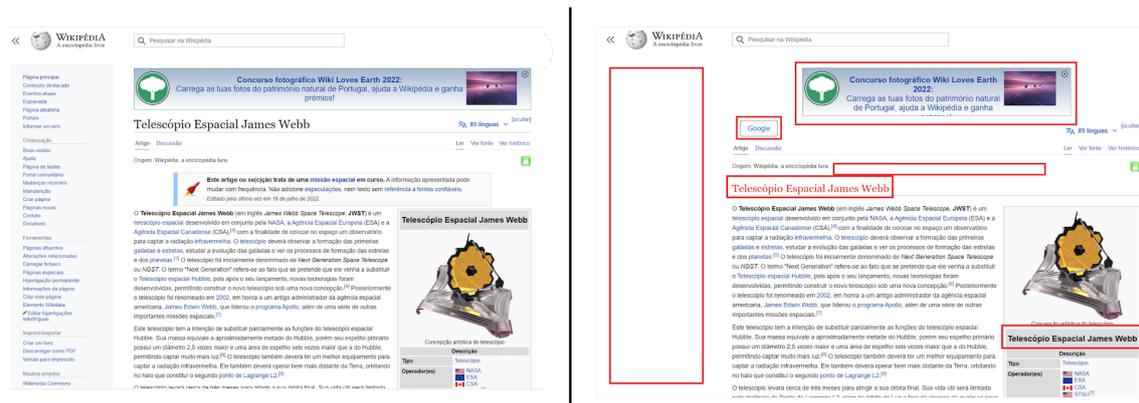
Figure 4.2: Training session task. Participants were asked to customize the original UI (left) to match the final personalized version (right). Red rectangles highlight the elements to be modified.

4.1.1 Procedure

We divided the study into three steps: (1) a session to familiarize participants with the study and *GitUI*; (2) a two-week period where they used *GitUI*; and (3) an interview session. We collected feedback on how to improve *GitUI*; however, our main goal was not to study its usability. Instead, we wanted to understand how people react to the concept of requests (creating and replying) and how that interconnects with the customization for the self, including contexts of use, motivations, or challenges. Sessions were audio recorded and held in a private room inside our university.

4.1.1.1 Think-Aloud Training Session

In this phase ($\approx$1h), a researcher trained participants in using *GitUI*. We wanted to ensure that they understood the concept of customization, *GitUI*'s operations, and the requests workflow (Appendix C.1).

Participants had to customize a website to look as close as possible to a provided final design (exploring all the customization operations available). This final design included a before-after image circling around components to change (Figure 4.2). We started by showing participants how to access *GitUI* in the browser and allowing them to complete the task without any specific order. We asked them to express their thoughts and perspectives about the system. The research team prepared an interview script containing elicitation questions to extract their perspectives when necessary. Participants should explore the tool independently, recurring to researchers' assistance when necessary. They used the research team's laptop to complete the task. This procedure lasted between 11.8 and 32.6 minutes (21.5±8 minutes).

Next, participants explored the requests. We clarified that they could create requests when they lacked the desire, availability, or expertise to customize themselves. We ver-

bally gave participants examples of what and how they could request and guided them through *GitUI* to demonstrate the process. We also demonstrated how to reply to requests. The research team did not set any guidelines regarding how to make or reply to requests. We also informed participants that their requests would be anonymous to other users and not to be concerned with request complexity.

After the task, participants completed the *NEO-FFI-20*, a 20-item Likert scale questionnaire ranging from 0 to 4 (Bertoquini and Pais-Ribeiro, 2006) and a computer self-efficacy scale, consisting of 10 items rated on a 1 to 10 scale (Compeau and Higgins, 1995). The *NEO-FFI-20* is a self-reported questionnaire that assesses the big five personality traits, which influence the customization for the self (Saati et al., 2005). We wanted to study if these traits or the computer self-efficacy of participants also impact how they customize or reply to customization requests.

4.1.1.2 Customization at Home

Participants should use *GitUI* for two weeks on at least three websites per week, either by customizing for themselves or creating an assistance request. Replying to requests does not count towards this minimum goal. We did not provide instructions regarding what and how to personalize, nor did we force participants to decide between customizing or asking for assistance. We pretended to create an experience as close as possible to an authentic one. We asked participants to act naturally and not force themselves to customize or create requests. We kept logs of their interactions with *GitUI*, including the frequency of use, customized websites, operations performed, or created and replied assistance requests. By providing them with equal opportunity to request assistance or customize themselves, we also wanted to understand the context and motivations for whether they prefer one or another.

The requests workflow was the following. When someone made a request, the research team manually assigned it to another participant (to ensure proper workload distribution). Each participant received a new request every two or three days. Participants could respond to these within 48 hours. If requesters did not obtain a reply, the research team ensured one. If there were no requests after the second day, and to ensure the flow of the study, participants received fictional requests. Every time there was a new request, participants were notified by email. Together with the request, they also received fictional information about the requester (name, age, and profession) to understand if it influences the replies. Participants did not receive any instructions for executing the requests. When participants did not reply to a request, they received an email informing them that the system assigned the request to another user. We only informed participants of fictional requests at the end of the study.

Fictional requests were rationally created by the research team before the study, exploring different personas, categories of websites, and complexity. In total, we pre-made

12 fictional requests. We internally labeled four requests with a difficulty of one, five with a difficulty of two, and three with three. The difficulty depends on the number and complexity of the necessary customization operations. Based on personas' age and profession, we had three requests that participants could interpret as deriving from tech-savvy people and four from non-tech-savvy. Three websites were from social networks and entertainment, five from information, and four from health or governmental resources.

Requests had different motivations, which we used to encourage people to explore different operations (e.g., color changes for accessibility or shortcut creations for efficiency). Participants received at least one request from each difficulty, website category, and tech-savvy level. We used a spreadsheet to record requests assignment, including dates or status, and manage subsequent assignments (based on the categories, date, and number of assignments).

An example of a simple customization request on a social media website[1] is: "*I do not care about the menu on the left. I just need a button to refresh the tweets on the page (Sarah, 60 years old, Lawyer).*"

More advanced requests could require code writing: "*I enjoy Reddit's[2] interface; however, one thing bothers me: the comments on a post are expanded by default when you open it. I usually only want to read the main comments, not the replies. I prefer having the replies hidden by default with an option to visualize them (John, 35 years old, Designer).*"

In total, we assigned 38 requests, 36 of them fictional. Participants replied to 31 (82%) of the 38 requests made.

4.1.1.3 Final Interview

We concluded the study with an individual interview about participants' general experience with *GitUI*, context of use, motivation, goals, and future personalization opportunities (Appendix C.3).

4.1.2 Participants and Recruitment

We recruited people with different technical and demographic profiles. In particular, we aimed to recruit expert and non-expert users, to understand their responses to the roles of requester and volunteer. We recruited participants using the university mailing lists and social networks. Participants should be internet users for more than four hours a week. They indicated interest by completing an online questionnaire. We rewarded participants with a voucher of €20.

In total, nine participants (P1 – P9), aged between 25 and 59 years (31.8±10.4 years), concluded the study (Table 4.1). Two weeks before the main study, a pilot study with

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[1]https://twitter.com
[2]https://www.reddit.com

Table 4.1: Participants profile, where HBI (hours a day browsing on the internet), CSE (computer self-efficacy), #Customization (total customization templates created for the self), #Requests (total requests), #Replies (total replies submitted for total requests received).

ID	Age	Expert	HBI	CSE	#Customization	#Requests	#Replies
P1	25	✓	8	8	1	0	4/4
P2	33	✓	12	10	0	0	4/5
P3	35	-	9	8.3	2	2	4/5
P4	59	-	9	5.6	7	0	4/4
P5	31	✓	12	6.7	8	0	1/4
P6	28	✓	10	10	6	0	3/3
P7	28	✓	12	6.6	6	0	3/4
P8	25	✓	9	8.5	6	0	3/4
P9	23	-	1	7	6	0	5/5

P1 and P2 ensured that our instrument worked and helped improve *GitUI*'s usability and stability. This procedure was similar to the main study. First, P1 and P2 performed the think-aloud training, which allowed us to estimate the session duration better, test *GitUI*, and adjust our interview script. Then, we instructed P1 and P2 to use *GitUI* at home for one week but without minimum requirements. They were aware of the pilot study but not the number of participants. Finally, we interviewed P1 and P2. We decided to include P1 and P2 in the results of our study as they still used *GitUI* enough times to provide valuable input.

4.1.3   Apparatus

We developed *GitUI*, a *Google Chrome* extension (Figure 4.1) that participants could freely use to create and apply customization templates on any website and to create and reply to customization requests. A template results from a set of customization operations, which can be updated or submitted as a reply. Templates can be specific to a web page or the whole website domain. Once saved, users can activate the template in the tool's menu. When activated, *GitUI* applies the template whenever the user visits the target web page.

Users can act as requesters or volunteers, depending on whether they are making or replying to a request. An assistance request consists of a website URL and a description, which, in the study context, the research team manually assigns to a volunteer. The volunteer then replies by submitting a customization template for the requester's use.

Users interact with *GitUI* through a popup menu that opens when they click the extension icon. The menu is divided into the *Customization* and the *Request* tabs. We developed *GitUI* using *JavaScript*, *HTML*, and *CSS*. It utilizes *Firebase* as the storage platform, and users log in with a single click using the account associated with their

browser. A demonstration video highlighting *GitUI*'s personalization features is available online[3].

4.1.3.1   Customization

The *Customization* tab (Figure 4.1 a)) allows to create and apply customization templates. The customization workflow is as follows: (1) if necessary, users start by defining the values (e.g., color) on the popup menu of the customization operation to apply; (2) they click on the operation name; and (3) they use the mouse to select a web page element to apply the operation (the system highlights elements on hover). To finish, they save the template and define a title and a description. Templates are associated with one user and can be activated (using the *dropdown* on top) and updated at any time. If none is active, users interact with the original UI. They can access a template list when visiting the target website or replying to a request.

   GitUI supports nine operations (motivated by previous work (Nebeling et al., 2013; Nebeling and Norrie, 2011) and studies) and *JS* or *CSS* injection into any web page. Users can apply operations with a single click, like the *Hide*, *Font-Size*, *Change Color*, or *Shortcut* (which, given a text and URL, inserts a link) or perform a 3-step process (where they adjust the element using the cursor and then press *Enter* to confirm) for the *Move*, *Reorder*, *Resize*, and *Spacer*. They can revert operations or press *Esc* to interrupt them. The *Inspect Element* and the *Advanced Editing* modal, with *CSS* and *JS* syntax checkers (Figure 4.3), complement these operations.

4.1.3.2   Requests

The *Request* tab (Figure 4.1 b)) enables users to create customization requests and view a list of the created requests and another with the received ones. There is no direct communication between users: (1) a requester submits a request; (2) the research team assigns it to a volunteer; (3) the volunteer creates a customization template for an anonymous requester; (4) the requester can access and use it.

   To create an assistance request, users fill out a form (Figure 4.4). They indicate the target website, write a detailed explanation of their wish, and, optionally, provide an image with visual cues. Users can verify the status of their created requests in the "*My Requests*" list. When a volunteer solves a request, *GitUI* notifies users through email and a notification icon. Requesters then access the "*My Requests*" list to download the reply template. From there, requesters can use the reply template as if they created it (e.g., further customize it).

   When users receive an assistance request, we notify them through *GitUI* and email. To reply to a request, users create a customization template (as usual) and submit it as a
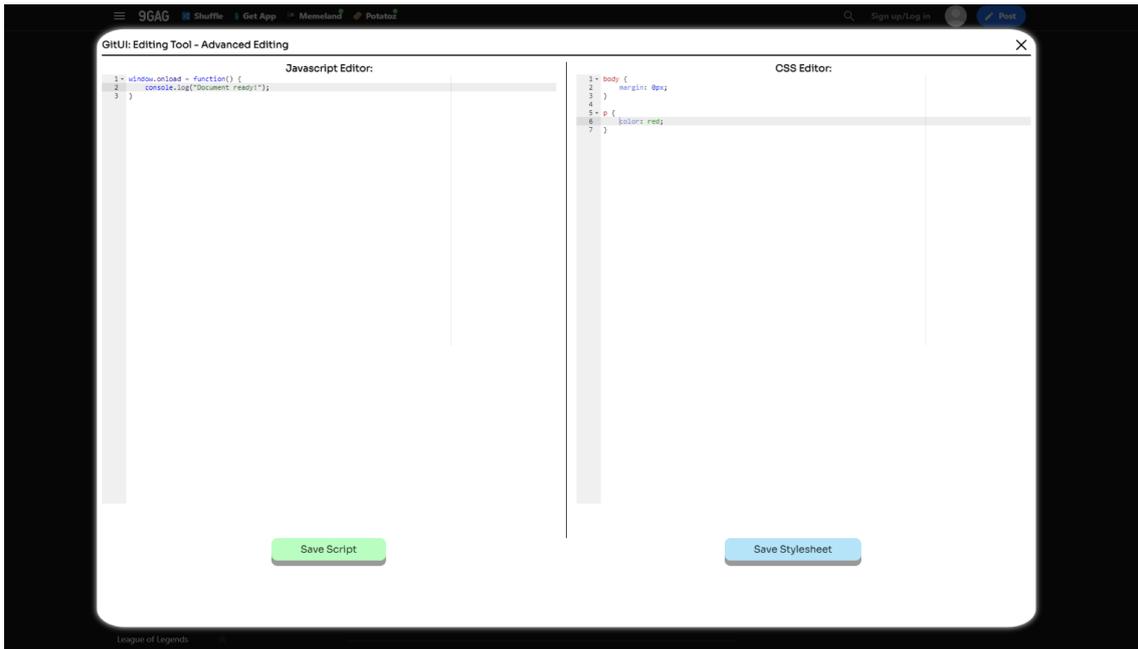
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[3]https://youtu.be/kos0J_ZOvpw

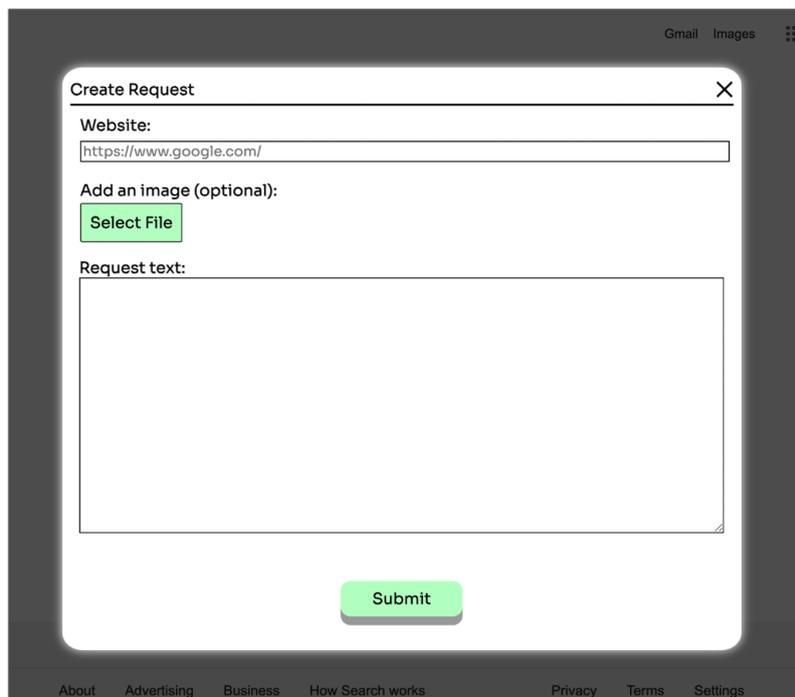Figure 4.3: The code editor of *GitUI* is a popup menu that opens at the top of any web page.

Figure 4.4: Interface for creating a personalization request using *GitUI*.

reply. To submit a reply, users open the received requests list, click on the request, and, in a *dropdown*, select one of the customization templates available for that website. In the study context, the research team verifies the reply and, if acceptable, makes it available to the requester.

4.1.4 Analysis

The two researchers who conducted the sessions analyzed the interviews. We performed a thematic analysis (Braun and Clarke, 2006) following the first three stages outlined by Halcomb and Davidson (2006), which do not require transcription of interview recordings. First, during all interviews, while one researcher conducted the interview, the other took detailed notes of relevant phrases, recurring ideas, and non-verbal cues, such as frustration and excitement. After each interview, the researchers held debriefing sessions. After the study, both researchers reviewed the audio records in consultation with the notes. They amended the notes to ensure that they accurately reflected the data. Relevant quotes to interpretation were carefully transcribed and examined. Then, we individually identified key codes across interviews and grouped codes representing similar phenomena into themes. In two group sessions, both researchers discussed, merged, and reviewed the themes to ensure they captured the depth and range of data collected across interviews.

For quantitative data, we calculated the mean, standard deviation, minimum, and maximum for continuous variables; and created tables of frequencies for nominal variables. We calculated the the *Pearson product-moment correlation coefficient* between each personality trait, collected through the *NEO-FFI-20* questionnaire (Appendix C.2), and the participants' activity during the study (Table 4.1), but found no relationship between them.

4.2 Results

In this section, we present the study results grouped by the three components we investigated: customization for the self, assistance requests, and customization for others. We conclude by reporting people's feedback on *GitUI*.

4.2.1 Customizing for the Self

Customization for the self was generally limited to the minimum (Table 4.1). Next, we describe the participants' experience.

4.2.1.1 Motivation, Context, and Benefits

Participants aimed to **simplify** and **optimize** web pages, reinforcing the findings from the previous studies: *"My goal was to eliminate the noise... to make websites simpler*
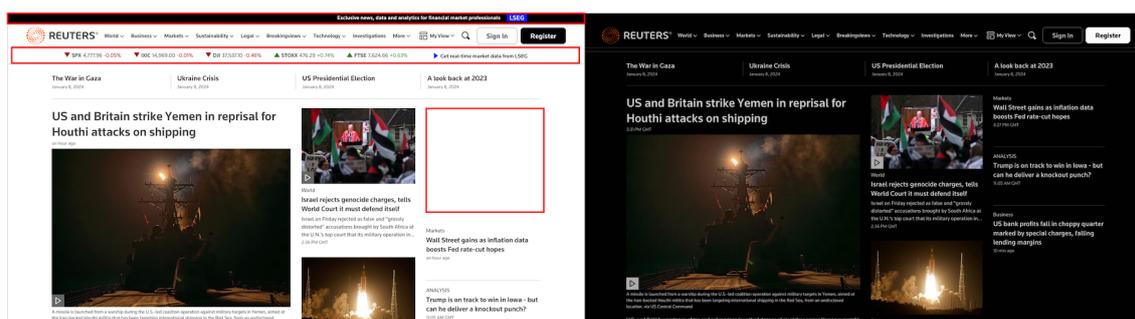
Figure 4.5: Example of a customization template: the original (left) and the customized version (right). P6 customized the colors, margins, and hid elements (hidden elements highlighted in red).

and more objective... add shortcuts" (P4). They pondered personalization decisions by personalizing the websites they visit more often: *"I know what I need in the websites I visit most (...) keep and reorder the most relevant information (...) I think 'this is what I want and I do not need distractions' "* (P9).

On the other end, created templates had no aesthetic focus except for creating dark themes. P8 commentated: *"I would only adapt aesthetics to be more efficient... which is my focus... but the design of the websites I visit is good enough"*.

Four customization operations were essential to meet participants' needs: the *Hide*, the *Shortcut*, the *Move*, and the *Reorder*. P6 also enjoyed customizing colors to create alternative color modes (Figure 4.5 is an example of customization on a news website[4]). P8, who valued the *Shortcut* operation, mentioned his desire for a more advanced operations: *"I would like the tool to redirect me to the web page I want... because what I did [throughout the study] was to add shortcuts"*.

Naturally, different users had different preferences. For instance, P6, an expert, mentioned only needing the *CSS* injector despite using the available operations when necessary (as shown in Figure 4.5). Nevertheless, most participants, including experts, preferred to use the built-in operations.

Participants benefited from using *GitUI*. P5, who assumed he would not become a user, mentioned the pleasure of accessing *"cleaner"* personalized web pages. P3 revealed interest in transferring her templates to her mobile devices. P9, despite *"not taking much pleasure in customizing"* (due to the necessary effort), confessed that the result was *"quite beneficial"* for her.

4.2.1.2   Challenges

Participants' most significant challenges in customizing for the self involved understanding what they could or needed to improve in UIs and what was possible to do with the customization tool.

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[4]https://www.reuters.com

Habituation and Ideation. Deciding what to personalize is challenging. People get used to existing UIs: *"I am already used [to UIs]... so I do not need that much of customizing"* (P7). However, for most, this does not mean that they do not want to personalize but rather have **difficulties in imagining possible modifications**: *"Opening a web page and thinking about how it could be improved is not easy"* (P3); *"It is difficult to escape from what we are used to"* (P8). P8 proposed the idea of accessing templates (similar to those presented in the *Templates* scenario, Section 3.2.1.2) as a way to support the visualization of potential UI improvements and prompt reflection on alternative layout possibilities.

UIs Conceptualization. Non-experts, particularly, did not **understand what they could adapt in a UI** or *GitUI*'s potential: *"As I did not understand the potential of the tool, I became a little unsure about how to use it"* (P3). For P3, customization was easier with *"directions or goals"*, such as when replying to requests. Additionally, P3 also believed that visualizing customization examples, like UIs with different background colors, would help her understand the tool's potential.

To help people become familiar with UI customization tools, P4 suggests gradually introducing different customization operations. For instance, as people get used to UIs, they would gradually gain access to more complex operations, allowing for more precise control over UIs: *"It would be good if we could progress across levels of control... to stimulate us to perform different operations (...) then [after getting used to those operations] we would want more (...) basically, this would be a game where people progress in the way they personalize UIs"*.

4.2.2 Requesting Customization Assistance

The adoption of the request creation feature was low, with only P3 using it. P3 assumed her motivation to make requests was to *"experiment"* with the feature and admitted she could not imagine herself using it in the future: *"It makes more sense for the elderly or people with disabilities"*. P3 assumed, however, that it was good to access her template done by others.

Participants justified the lack of requests by mentioning that they preferred to customize interfaces themselves. We identified six factors supporting this attitude: self-efficacy, sense of control, selflessness, time and effort, articulateness, and self-perception.

First, most participants (experts and non-experts) mentioned that if they have a problem to solve, they will always try to solve it by themselves and only then request assistance, if necessary. This may be a consequence of the high **self-efficacy** level of participants (Table 4.1), as most mentioned having enough confidence in their skills to not ask for assistance: *"I believe in my skills (...) if I can not do it, other people would not be able to do it either"* (P8).

Second, people value a sense of **control**. Prior work (Marathe and Sundar, 2011) shows that feeling in control is a key motivator for customization. Control involves making one's own decisions about what and how to customize. Requesting customization assistance can make people lose part of their sense of control. As P6 and P8 put it: *"I like to do things myself"*.

Selflessness is the quality of thinking more about other people's needs than about your own[5]. The influence of **selflessness** was evident with P5, who assumed he would not request assistance because he did not want to overload others. P5 only needs help with complicated operations that he can not perform. A request system would only be an option for him if he could make the requests directly to the website owners/developers.

Participants also mentioned the **time and effort** necessary to request customization assistance. P5 believes that he would only ask for assistance to perform an extensive redesign, which would be challenging as he would need to *"invest one day to think about the design of the new version of the website"*. P8 mentioned that to request what he *"really desires"* would make him lose as much time as if he customizes himself.

People must also describe their needs quickly and clearly (i.e., **articulateness**). P4 mentioned an expected difficulty in describing her needs and revealed concerns that others would not understand her requests. The participant compared the received requests with the ones she could make, noting that hers seemed *"more generic"*.

Finally, participants' self-perceptions of *GitUI* users suggest the emergence of two distinct roles: those who provide assistance by responding to requests and those who seek help by making them. As P2 noted, *"I belong to the group that does not ask for help"* (P2).

4.2.3   Supporting Others to Customize

Participants enjoyed the experience of supporting others to customize. They did not face significant challenges, and each dealt with the different degrees of complexity of requests in their own way. For instance, experts injected *CSS* rules to address a request to hide *YouTube* thumbnail previews, while non-experts manually used the hide operation in all thumbnails. For more confusing requests, P9 confessed the need for a *"visual clue"* (e.g., a screenshot with an illustration), and P9 doubts about implementing some solutions: *"I thought 'how do I reply with the tools I have?' "*.

Most participants assumed they would install *GitUI* only to assist others. They developed strategies and began allocating parts of their day to responding to requests. For instance, P1 mentioned, *"If the tool eventually becomes available, I would like to receive a request every morning"*. In contrast, P5, who provided fewer responses, believed that users should learn to customize themselves instead of asking for assistance.

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[5]https://www.oxfordlearnersdictionaries.com/definition/english/selflessness

4.2.3.1   Motivation: The Daily Challenge and the Emotional Reward

Two key factors motivated people: the challenge and the emotional reward (e.g., gratitude or connection with others).

Half of the participants mentioned the concept of challenge. They see a request as a challenge someone is making, and their motivation is to solve that challenge. P6 and P7 referred to it as the ***"daily challenge"***. P4 mentioned that *"the challenge itself was the motivation to reply to requests (...) it is challenging"*. P4 assumed not thinking about the requester and explained: *"I saw each request as something to overcome... if it helps someone even better... but it is more like a game"*.

Another motivation was the **positive feeling of helping others**, for some, similar to the feeling of helping others in a physical context: *"It is funny to use the tool and it feels good to help others"* (P2); *"The requests were simple things that I did quickly... and I felt good about it... even if it is just an initial, basic, template that others can later update"* (P1).

We also explored if accessing the requester's profile can influence if and how people reply to requests. For most, it had no impact. However, for P2, accessing the profile motivated her: *"I like to know the information about whom I am helping (...) I imagine a face behind the request"*. The same goes for P9: *"It makes the request more personal... it is not the details [profile] that matter (...) I even save templates with the requester's name... it creates a good feeling"*. Additionally, knowing the requester's profile can help prioritize requests (in a situation where multiple are available): *"I would always prioritize requests with more impact... for example... helping blind people"* (P2).

4.2.3.2   Leveraging User Engagement

To support volunteers better and improve integration and motivation within a community, participants highlighted two key aspects: **gamification** mechanisms and **feedback** on replies.

Gamification.   Gamification mechanisms aim to drive user engagement in an activity (Wood and Reiners, 2015). It includes components like points, badges, and leaderboards to represent and measure success, rewarding challenges, cooperation, or users' feedback. Participants mentioned that gamification components could be part of *GitUI*, as illustrated by comments like: *"Have you [the research team] ever thought about including gamification?"* (P3) and *"It would be great to have at least a star classification system"* (P8). The first three participants proposed gamification ideas, so we included questions about gamification in our interview script.

Interestingly, the suggested gamification mechanisms aim to leverage the motivation factors: the challenge and the emotional reward (Section 4.2.3.1). First, participants want to be **recognized for their successful replies**, such as through a ranking or classification

system. Those who customize more and better than others want their achievements to be public and comparable. For instance, when the researcher told P6 he needed one more reply to match the participant with the most replies, he responded: *"send me two requests then"*. Meanwhile, P7, a *fan* of the challenge of customizing for others, took it a step further, mentioning the idea of *"personalization teams"* competing against each other, *"like teams of different universities"*.

Furthermore, participants suggested using **gamification components to allow requesters to demonstrate their gratitude and increase volunteers' emotional reward**. For instance, for P3, the most important aspect is not to have a rating system but to access her contributions: *"I would like to see how many times I helped others (...) that would enhance the positive feeling of contributing to something"*.

Overall, although all participants favored gamification mechanisms, they assumed it would not be a decisive factor in motivating them to install a system like *GitUI*. For instance, P8, who assumed he would not become a *GitUI* user, mentioned: *"[gamification] could not keep me motivated; I would always have other priorities"*. For P4, gamification components *"can feed the ego (...) feed anyone's ego (...) but it is not the most important"*.

Feedback and Communication.   **Feedback** on replies was a crucial missing feature in *GitUI*. For P1, *"even a simple message saying 'your reply was accepted'"'* would motivate volunteers more and *"generate gratitude"*. Additionally, for some participants, it would be good to communicate with the requester and ask for clarification or feedback about an ongoing or delivered customization. For instance, due to the current lack of communication, P7 assumed that, while customizing for others, he customizes according to his own preferences (i.e., in a way he considered the resulting personalization enjoyable for him).

However, the option to communicate with the requester lacked consensus. P3 believes that having an online chat could create *"too high expectations on requesters"*, letting them believe that replies would be *"perfect"*. For her, the best solution would be to have feedback on the replies, which the volunteer could use to improve the template. P3 confessed that it is *"intriguing"* to be unsure whether she understood the received requests. For P4, who assumed that accessing requesters' profiles is nonessential, having access to feedback can help her get closer to requesters: *"I would understand that there is a person on the other side"*.

Managing Volunteers' Confidence.   Two other components were discussed as ways to keep volunteers motivated. First, recognizing that their volunteer work contributes to UI improvements can give them extra motivation to continue helping others. P9 mentioned: *"After seeing the reply I made, I saw that it really improved the UI (...) it somehow motivated me... to have done something that turned out well"*.

Second, receiving requests that align with their availability, abilities, and willingness to help can also be important for volunteers. While participants consistently attempted to reply (even to complex requests), P9 felt more confident when handling easier ones. She perceived that her replies to simpler requests had better quality, which kept her motivated to reply to subsequent requests. She mentioned the desire to use *GitUI* *"in a convenient way"*, preferring to respond primarily to straightforward requests that give her a sense of accomplishment.

4.2.3.3   Community and Social Requests

Participants naturally introduced the concept of community during the discussion. For instance, P4 mentioned a desire to be **part of a community**: *"[the tool] can even form a community that works"*. To build this community, people mentioned the importance of being able to accept assistance requests and lock them (i.e., preventing others from replying once a volunteer commits). For P3, being able to select and lock requests would provide a *"feeling of greater control and freedom to volunteers"*, allowing them to commit only when they are available and confident in their ability to respond.

We also explored participants' reactions to the possibility of receiving requests directly from other users, like their friends. Overall, the idea was well accepted. For instance, P8, who assumed he would not be an active volunteer, is more open to personalizing for friends and family: *"I would reply to all"*. P5, who also would not assist others, assumed the possibility to reply to more personal requests: *"For strangers, I feel like there is no connection"*.

4.2.3.4   Influence on Customizing for the Self

Customizing for others shaped how participants approached the process of customizing for themselves. For P7, the **requests received served as inspiration** for templates he could create for personal use. For example, some requests encouraged him to simplify interfaces by removing unnecessary elements and repositioning the remaining components.

P2 and P3 shared a similar perspective. While reading the requests, they reflected on what they could personalize for themselves and how to explore the *"tool's potential"* (P3), particularly by considering how to make use of each available operation. This enabled P3 to develop a more critical attitude towards UIs. P3 also mentioned that responding to the requests provided part of the guidance she needed, helping her discover personalization features she might not have explored otherwise. Requests also impacted the customization decisions of P5 and P8; however, by reminding them that they were part of a study, where they should customize for themselves.

4.2.4 User Experience and Usability

In this section, we report participants' experience with *GitUI*, including the first contact during the think-aloud training session and the aspects reported in the final interview. The study's goal was not to evaluate the customization tool but to collect helpful feedback for future customization solutions and improve our prototype.

Learning Curve. During the training session, participants successfully learned how to use *GitUI* and showed confidence in using it independently at home. They initially felt anxious, as they were uncertain about what to expect from a UI customization tool. However, their confidence grew as they started reading the names of the operations and relating them to the task. To execute the task, most participants started with the *Hide* operation, which they assumed to be the easiest. Overall, once participants got used to the workflow and the meaning of operations, they quickly finished the tasks.

Workflow. The most commonly encountered issue occurred at the beginning of the task, as participants were unsure how to select an interface element to apply an operation. For most, the first customization step involved attempting to select UI elements (such as text) and waiting for a pop-up to provide any information about possible customization options. With assistance, participants understood that they needed to select the operation first. While they quickly adapted to this workflow, they felt that selecting the element before choosing the operation would have been more intuitive.

Experimentation. Participants were often unsure of the exact values of the properties they were trying to edit (e.g., the color or font size), so they felt the need for experimentation. Ideally, they would select an element and then experiment with the operation and values to apply. However, for operations like *Font-size*, users could experiment by simply increasing/decreasing the size without specifying a value.

Agility and Fluidity. Participants sought a more efficient personalization experience. Following standards set by other software, such as spreadsheet editors, they wanted the ability to select multiple elements and apply the same operation to them, or conversely, select an operation and apply it to multiple elements. They also desired the option to keep an element selected and apply multiple operations, or to propagate operations within a container. P5 also suggested incorporating keyboard shortcuts to improve the agility of selecting operations (e.g., *M* to move).

A particular term mentioned by participants was fluidity. They expressed the need for the menu to remain open between operations or, alternatively, for a *pin* button to allow users to decide whether the menu should close (*Google Chrome* does not allow pop-up menus to stay open when users interact with web pages). Additionally, once users define

the properties of an operation (e.g., select a color), the operation should be automatically activated (i.e., without having to press any other button).

Feedback and Guidance.   All participants mentioned wanting more guidance and feedback during the customization process. Specifically, they suggested that the mouse cursor could change to provide visual feedback about the ongoing operation. Additionally, *GitUI* should include step-by-step instructions to guide users throughout the process. For the *Move* and *Reorder* operations, participants desired a better highlight of the element being customized and its possible final positions.

***GitUI* Operations.**   Participants understood and were able to use all operations. However, the *Reorder* operation, which allows elements to be reordered within a container, raised concerns regarding both its logic and execution. Participants found the *Move* operation, which enables users to place elements in different containers, easier to understand.

Regarding missing features in *GitUI*, participants agreed on the need for a *Background Color* operation, which they considered as important as the *Font Color*. P6 also wanted to customize the padding, similar to what was possible with the margin. Beyond that, the needs were highly dependent on individual goals. For example, P5, who valued organization more than aesthetics, desired to optimize his navigation workflows. P8, in a similar situation, wanted to create automatic redirects to other web pages and automatic search and sort filters.

4.3   Discussion

In this chapter, we studied the dynamics of a customization apparatus where people can assist one another in personalizing their UIs. Supported by a custom-designed tool, *GitUI*, we explored the context, motivation, and challenges of customizing for the self, requesting customization assistance, and helping others to customize. In this section, we discuss our main findings.

4.3.1   Customization Challenges: Guidance and Ideation

Participants' adoption of *GitUI* to customize for themselves or request assistance was limited to the minimum. While *GitUI* did not support all the desired operations (e.g., workflow optimization), it was not a technical issue preventing customization: people have difficulties understanding how their UIs can be improved or even realizing how to take advantage of the features provided by a customization tool. To this end, reflecting on the received customization requests can increase people's awareness about personalization possibilities, which suggests benefits from making part of these requests publicly visible and discussed (i.e., open to a community).

Simultaneously, our findings reinforced that **people need help with the ideation process** (i.e., making design decisions). Based on their hands-on experience, participants proposed potential solutions to facilitate this process, including visualizing various layout alternatives for inspiration and experimenting with different layouts or properties to identify one that aligns with their expectations.

We believe that **customization templates**, which can be further edited and adjusted to personal preferences, can be a solution to deliver different layout alternatives and support experimentation. Templates could be generic, semi-automatic, or created by the community. Generic templates would be similar to the templates available when creating a new presentation with a presentation program, which generally inspire people. These could be initially randomly generated but improved as the system increases its knowledge about users. Automated approaches could be used to provide more accurate templates. Community templates could follow the concept of *Stylish* (SimilarWeb, 2022b), where people can share, access, and use templates created by others. Regardless of its origin, the ability to further customize a template or selectively import only certain operations would be relevant to ensure transparency (Jameson, 2007) and user control (Marathe and Sundar, 2011). For instance, users could be presented with a list of all operations applied in a given template and choose which ones to incorporate into their own.

Extending the ideas introduced by Mackay (1991), we suggest two additional approaches to encourage further personalization and support users' ideation process: (1) **creating situations to allow users to reflect on their UIs** (the received requests provide these situations); and (2) **bringing users into contact with each other** to share customization ideas or requests, which can increase the applicability and usefulness of individual customization decisions.

4.3.2   Supporting and Fostering Customization Requests

In Chapter 3, we found that people have difficulties in proposing personalization solutions. In this study, we allowed users to focus solely on making requests by expressing what they wanted to change without reflecting on how to implement it. This approach could have encouraged personalization. However, participants did not feel the need to create requests.

Before investigating other reasons behind the lack of created requests, future studies should prioritize supporting the guidance and ideation processes. If people do not desire to customize – whether because they do not see how their UIs could be improved, do not recognize the benefits, or do not find interaction issues requiring optimization – they are logically unlikely to seek assistance. Therefore, future work should focus on **highlighting the personalization value** by exploring the previously mentioned solutions to the ideation challenge and raising awareness of personalization benefits.

The ideation problem does not devalue the importance of further studying how to support users in communicating their requests and streamlining the process. *GitUI* offers a

straightforward UI to create requests, and the articulateness of the request's description was pointed out as an issue. Existing work showed that even for designers, communicating UI changes is challenging, resulting in the need for a feedback loop to visualize changes or refine descriptions (Chen et al., 2021).

Today, users usually communicate their desired design or behavior changes to UI creators using simple cues (e.g., "thumb up/down" buttons) (Benlian, 2015). However, these cues can be insufficient to communicate personalization intentions. Future research can work on top of more advanced communication methods, like the ones from UI behavior retargeting research (Chen and Grossman, 2021; Chen et al., 2021), and use visual references to support communication. For instance, *CoCapture* (Chen et al., 2021) enables users to create and describe dynamic UI behavior using mockups. The mockups contain changes that users want to propose to UI creators or questions about existing UIs. These communication mechanisms, which in this case are used by experts to build generic UIs, can be further explored to facilitate communication between experts and non-experts or requesters and volunteers.

Additionally, the progress of conversational agents, like *ChatGPT*, also opens up space for **human-machine collaboration**, for instance, helping users describe their requests, bridging (e.g., "translating") the communication between experts and non-experts, or even supporting the ideation process. York (2023) found that *ChatGPT* responds well to brainstorming and ideation prompts but not so well to design prompts, suggesting it can be explored to support the formulation of design challenges, ideation, and communication, leaving its implementation to human volunteers. However, with advances in interface understanding, such models could also begin to support implementation, at least in part. For example, they might generate initial personalization templates in response to user requests, which users could then review and refine.

4.3.3 Motivating Volunteer Work

We found that **users are motivated to assist others to customize by the positive feeling of being helpful and by the challenge it represents**. Helping others increases happiness (Post, 2014), improves mood, and reduces stress (Midlarsky, 1991). Future work can further raise their motivation and confidence by including gamification mechanisms, particularly to leverage these factors and let them know how many users they have helped (Rashid et al., 2006).

The motivating factors we found align with typical factors impacting general forum-based systems. For instance, *Stack Overflow*[6] users are mainly motivated to contribute to the community by intrinsic factors (Lu et al., 2022), which include helping others, reciprocity, and making an impact (Penoyer et al., 2018). Nevertheless, *Stack Overflow*

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[6]https://stackoverflow.com

users still benefit from gamified incentive mechanisms, for instance, for sharing their reputation on other platforms (SimilarWeb, 2022a).

We believe that the factors motivating people to participate in the open source movement (Heron et al., 2013a) can also encourage people to become volunteers in a system like *GitUI*. Factors like perfecting expertise (Lakhani and Wolf, 2003; Von Krogh, 2003) or enhancing reputation (Bezroukov, 1999) can be important for experts. Meanwhile, broader incentives like altruism (Benkler and Nissenbaum, 2006), expectation of reciprocity (Morgan, 2000), or fun and enjoyment (Bezroukov, 1999), could appeal to volunteers in general. Our results also highlight the importance of other factors, such as enabling individuals to **choose their level of participation** (Anthony et al., 2005) and to self-select their contributions (Fuchs, 2008), that is, allowing them to self-commit to the requests they wish to address.

Similarly, future research should focus on **adapting the complexity of requests to volunteers**, which can be used to increase their motivation. Most participants assumed to be open to creating requests but only for more complex customization operations that require expert knowledge. However, we should not waste the availability of non-expert volunteers. To not do so, customization research can apply crowdsourcing concepts (Liu et al., 2013) to handle complex assistance requests. This includes allowing people to collaborate on a single task by breaking it down into microtasks with different complexities.

4.3.4 Impact of Expertise and Personality Traits

We aimed to understand how expertise and personality can affect the customization for the self and others. While our data does not support conclusions regarding the influence of personality traits, our results suggest that people with different expertise exhibit similar behaviors when deciding to customize, ask for assistance, or help others. Participants shared characteristics like self-efficacy or the need for the "daily challenge" that may have resulted in similar reactions to the requests received. This behavior is an encouraging finding, as previous studies (Sundar and Marathe, 2010) revealed that less tech-savvy people can demonstrate negative attitudes when asked to customize.

In contrast, we observed that participants' level of expertise can influence how they customize, shaping how they conceptualize UIs (e.g., their understanding of a web page's structure) and how they expect to engage with *GitUI*. For instance, while non-experts desired a customization workflow and interface aligned with the standards of mainstream software (e.g., word processors), experts sought more advanced interaction techniques (e.g., keyboard shortcuts). Similarly, while experts resorted to *CSS* rules to perform repetitive operations, non-experts found the process tedious. Future work with a larger participant sample and a greater emphasis on customization requests should further explore these differences, ensuring future personalization software considers them.

4.3.5   Technical Learning for Customization

Our study followed a qualitative approach. Focusing on a small number of participants, we complemented previous work with in-depth insights (gathered over two weeks of usage) into what people expect from a customization tool. Future solutions should focus on **supporting the process of experimenting with different values and properties**, **guiding users** during the customization process (with visual cues), and, above all, allowing for **personalized customization workflows**. For instance, people should decide whether they want to apply the same operation to multiple elements or multiple operations to the same element.

We encountered technical challenges that are useful for future research, particularly given that the Web is a complex ecosystem where developers have total freedom in defining design, workflow, and implementation languages. Therefore, the main challenge lies in dealing with all the constraints this diversity imposes. Additionally, web pages are frequently updated, resulting in customization templates with a short life span. Future research should explore solutions to detect and correct broken templates or notify users when templates are no longer functional. Another vital aspect is scalability: future solutions should minimize duplicate requests or automatically identify solutions already available to new requests, potentially using text mining techniques.

4.3.6   Implications for (Community-Based) UI Personalization

We envision a community-based approach to personalization that fosters collaboration between individuals with different skills and expertise. This study was a first step. We wanted to understand if people can collaborate towards producing personalized interfaces and how a system can support that process. Table 4.2 summarizes our findings that inform future community-based personalization approaches and customization research in general.

4.3.7   Limitations

The low number of created requests limited our findings, preventing us from studying aspects like people's capacity to describe desired UI changes or possible ways to support that process. Nevertheless, the concept was well received, and most participants showed interest in helping others and asking for assistance when necessary, justifying the need for future exploration of the community-based UI customization concept.

Furthermore, most participants, whether experts or non-experts, were inclined to use our tool outside the study scope, but primarily to provide customization assistance. In this scenario, the challenge and positive feeling of helping others are already positive incentives. However, fully comprehending long-term user engagement requires a study

Table 4.2: Lessons learned according to each research question.

Customizing for the self – context, challenges, and motivations (RQ1)
• People's primary motivation to customize is simplifying and optimizing web pages.
• Problem identification and solution ideation are the biggest challenges to customization.
Requesting customization assistance – context, challenges, and motivations (RQ2)
• Access to customization assistance does not increase people's willingness to customize. This suggests that, besides reducing the required customization effort, which would be mitigated by requesting assistance, people must understand personalization benefits and existing UI problems.
• Complex customization problems can provoke people to request customization assistance.
• Self-efficacy, sense of control, selflessness, time and effort, articulateness, and self-perception represent challenges to requesting customization assistance.
Providing customization assistance (RQ3)
• People intrinsically enjoy customizing for others.
• The positive feeling of helping others and the challenge it represents are the main motivators for volunteer work.
• Volunteers need feedback on replies and to discuss customization details when necessary.
• Typical forum-based gamification mechanisms can be adapted to the customization assistance context by creating a reputation built on the number of people a user has helped.

longer than two weeks, during which the introduction of gamification mechanisms can prove crucial.

The inability to identify and articulate personalization needs challenges our community-based approach, which relies on individuals' intentions to customize, individually or through the community. Nevertheless, these challenges are not unique to our approach; they extend to user-driven personalization in general, underscoring the necessity for future research to support the identification of personalization opportunities. Also, performing a study with a longer duration can offer additional perspectives. For instance, most *Stack Overflow* users participate less than once per month, although most still feel part of the community (SimilarWeb, 2022a).

GitUI was exclusively developed for *Google Chrome*, which is not the main browser of P2, P6, and P7. These participants assumed that this reduced their motivation to use the tool and revealed interest in transferring their templates to their main browser.

4.4   A Community-based Personalization Approach

As previously discussed, our community-based approach to UI personalization allows users to customize for themselves, request assistance from others, or install publicly available templates. This model supports secure and transparent collaboration, enabling users to co-create and address requests following the principles of *GitHub* (Dabbish et al., 2012) or crowdsourced web site components (Nebeling et al., 2012). Templates could be private or public, ensuring others could redesign or combine them.

In this dissertation, we focused our investigation of community-based personalization on the dynamics of personalization assistance, as it was unclear how users would get involved in the process. In contrast, other individual components of the community-based personalization setup, such as the customization toolkit and the template repository, had already been explored in prior work (Nebeling et al., 2012) and are already part of some users' digital routines (SimilarWeb, 2022b; Dabbish et al., 2012).

Overall, our findings suggest that community-based personalization is feasible and well-accepted. People are open to volunteer work, which is crucial for the proposed approach and underscores the potential for further research in this area.

This section presents a refined version of the community-based personalization concept. While we had an initial vision for it prior to the study, this vision evolved through ongoing discussions and the insights contributed by participants throughout this chapter.

4.4.1   The Importance of Community-Based Personalization: Use Cases

The following use cases attempt to exemplify the usefulness and novelty of our approach.

Requesting Assistance.   *Robert, a 55-year-old researcher, is passionate about staying updated on the latest publications in his research field. He uses Google Scholar[7] to search for scientific articles and track new work from his favorite researchers. However, when visiting the website homepage, he finds no information about his favorite authors or interests. Observing unused space on the UI, he envisions a way to integrate this information directly into the interface. Recently, Robert discovered a community-based personalization platform. Using its customization toolkit, he begins modifying the homepage, adding shortcuts to frequently visited content. As he works, he realizes that the experience could be further improved by creating a dynamic table that displays this information and can be easily personalized, so that users can conveniently add or remove shortcuts based on their preferences. Recognizing this is a complex operation requiring code writing, he decides*

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[7]https://scholar.google.com

to request assistance from the community, submitting an assistance request describing his need to seek support.

Volunteering.   *Lisa, a 40-year-old computer engineer, enjoys using her free time to help others. She has an account on several question-and-answer websites (e.g., Stack Overflow[8]), including on a community-based personalization platform. Each day, she accesses the platform to see if anyone needs assistance. Lisa came across Robert's request and decided to help him. After discussing potential solutions and refining the idea together, she implemented a solution that meets his needs. Robert is happy with the solution and asks Lisa to make it publicly available to others.*

Evolving Templates.   *Helen, a 28-year-old lawyer, is color blind. As an active user of the same community-based personalization platform, she frequently browses the public repository for solutions to improve her digital experience. While she can also consult templates for specific UIs as she uses them, she enjoys exploring new customizations that might improve accessibility. Helen finds Lisa's solution. However, she needs to customize the colors further. Helen submits a request for assistance, which John, another community member, volunteers to address. John installs Lisa's solution, customizes it, and publishes it online as a branch of the original solution with the tag "color-blindness". Helen installs John's template. Besides improving her experience, Helen now realizes that some colors have a relevant meaning for understanding some UI functionalities.*

4.4.2   Community-Based Personalization in Practice

A community-based approach to personalization should consider at least three components: customization for the self, customization assistance, and a customization repository. Customization for the self requires a robust customization toolkit. Other activities could be centered in a community hub (repository), where people could collaborate and discuss templates or requests. These discussions could benefit from being public, as others may share the same problem or personalization intentions.

4.4.2.1   Customization Toolkit

The concept aims to empower citizens by ensuring they can customize any UI and UI element with a customization toolkit. This toolkit should function across any UI and support direct manipulation of elements. Unlike existing solutions (Biniok, 2022; SimilarWeb, 2022b), which require programming skills, the software should follow the example of *CrowdAdapt* (Nebeling et al., 2013). *CrowdAdapt* provides a set of operations that allow

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[8]https://stackoverflow.com

people with varying skill levels to graphically manipulate UIs using a mouse or keyboard, making customization more accessible and intuitive.

Operations. Customization operations should be driven by people's needs, including those related to efficiency, simplicity, aesthetics, and accessibility. In addition to the *Move* and *Resize* operations, identified as essential in *CrowdAdapt* (Nebeling et al., 2013), our findings underscore the value of also including *shortcut*, *remove*, *reorder* (for menus), and color-related operations in customization software.

To facilitate the use of these operations, users should have the flexibility to experiment with different values and properties before applying changes. In extreme cases, the system could suggest values based on established design guidelines or past templates the user has installed.

Simultaneously, the operations should balance simplicity and control: experts or self-learners should not be constrained by the toolkit. Therefore, advanced customization through code-based edits should be supported, enabling users to modify UI elements programmatically. This includes features to assist users in identifying and selecting elements for personalization (e.g., displaying *HTML* class attributes) and integrating a code editor with auto-complete and syntax-checking capabilities.

Templates. The result of a set of customization operations becomes a template. We found that the concept of customization templates works well and is easy to understand. People should decide whether a customization template is applied/active. They should also be able to redesign and experiment with existing templates and apply multiple complementary templates to the same UI.

When the original UI is updated, the system should detect any affected personalization templates, notify users, and support them in updating those templates. For example, it could highlight visual differences or prompt users to select which operations should be transferred to a new version compatible with the updated UI.

Customization Assistance. As discussed before, customization assistance is important for problems that people can not solve independently. This approach can ensure crucial customization motivators (e.g., the sense of control and identity) for users who lack skills or availability. Ideally, original software developers would provide this assistance, but members of a customization community can also do it, following existing approaches like *Stack Overflow*.

Requesting assistance or collaboration does not need to be a burden for community members. Regardless of expertise level, volunteers may already be familiar with a specific UI or possess a template that requires only minor adjustments to be helpful to others. Volunteer work can range from building an entire template to performing a specific operation

on an existing one.

4.4.2.2   Customization Repository

The repository serves as the central hub of the community. Users should have the option to publish their personal templates, making them accessible to others seeking similar solutions. Connected with the toolkit, the repository should allow users to browse and install public templates while offering a secure and transparent environment for collaboration on templates and requests.

Beyond sharing templates, the repository should foster community interaction by enabling users to discuss templates, collaborate on requests, and report issues. Public discussions can be especially valuable, as multiple users may encounter the same challenges and collectively work to find a solution.

Community-Based Templates.   Templates should be flexible and easy to adapt to personal preferences. Inspired by distributed version control systems (Dabbish et al., 2012), users should also be able to clone, modify, and republish templates as separate branches. To ensure safety and transparency, all public templates and replies should be tested for malware, and their underlying code or operations should be visible to potential users.

Browsing Experience.   The repository browsing experience should follow the concept of *Stylish* (SimilarWeb, 2022b), enabling users to filter templates by device type, website, rating, or popularity. In addition, unlike *Stylish*, it should support filtering by category, such as *accessibility*, *readability* or *color blindness*. This extended functionality would allow the system to suggest templates based on users' personal characteristics, needs, or the websites they visit.

Community-Based Assistance and Collaboration.   Users can assist each other, and any user can volunteer. Each individual has unique expertise that can benefit the community. Assistance requests should be addressed in the repository, allowing requesters to search for requests describing similar problems and volunteers to select requests and collaborate to find a solution. Requests should be categorized so that people interested in helping can follow requests on specific topics or websites. Furthermore, over time, users may develop expertise in personalizing certain UIs, making their contributions more effective and targeted.

However, it is unclear whether requests should be "*locked*", as suggested by P3. One the one hand, implementing a locked request mechanism prevents unnecessary duplicated work. In this scenario, requests would automatically unlock upon completion, withdrawal, or after a set timeout. On the other hand, keeping requests open to multiple

volunteers would allow requesters to select the best reply, similar to the *Stack Overflow* approach.

In addition to providing assistance, users may also collaborate proactively to develop and refine templates that address shared needs or commonly used interfaces.

Gamification and Long-Term User Engagement. Following the concept of *GitHub* or *Stack Overflow*, users could build a reputation that rewards the quality and quantity of the published templates, assistance provided, or assistance requests. Reputation metrics could consider factors such as the number of contributions, user ratings, and the number of people who have benefited from shared templates (Rashid et al., 2006).

4.5 Summary

In this chapter, we explored how people customize for themselves and how they react to being able to request customization assistance or help others to customize. We went deep into this concept by performing an exploratory study with nine participants, where they independently used a customization tool, *GitUI*, for two weeks.

Our results suggest a high interest in volunteer customization work, but revealed people's difficulties when customizing for themselves. People need more guidance and help with the ideation process to customize for themselves. In contrast, when customizing for other users, they are motivated by the positive feeling of helping others and the challenge it represents.

Building on our findings, we proposed a community-based approach to UI personalization, aiming to foster collaboration, discussion, and sharing of personalized UIs among members. Future work should prioritize studying ways to trigger and support people's personalization intentions. This includes solving the challenges of ideation and guidance, both essential for fostering individual customization and request creation.

Chapter 5

Reflections on the Role of Interaction Data in Empowering User Decision-Making for UI Personalization

Although people are interested in personalizing their user interfaces, many do not fully take advantage of existing personalization features. This is often due to difficulties identifying what to change (Chapter 3, Chapter 4), the effort involved in adjusting interfaces (Group, 2024; Mackay, 1991), or a lack of clear and immediate benefits (Banovic et al., 2012).

Chapter 4 explored how community-based assistance could help reduce the effort of personalization. While participants recognized the value of collaborative personalization, they still struggled to engage with it, as they were unsure how to improve their interfaces or what benefits those changes might bring.

Encouraging personalization requires creating opportunities for users to reflect on their interactions with UIs (e.g., understand repeated navigation patterns (Mackay, 1991)), supporting design thinking and problem-solving (Chapter 3), and highlighting personalization benefits (Banovic et al., 2012). However, existing solutions (e.g., *Stylish* (SimilarWeb, 2022b)) lack support for reflection and decision-making, compromising its effectiveness and adoption (Chapter 4).

While personalization in general is increasingly shifting toward more system-driven approaches (e.g., algorithmic content feeds and recommendations (Wu et al., 2022; Bucher, 2017; Montag et al., 2019)), where software makes decisions on users' behalf and personalization effort is on the system side, it remains important to consider balanced approaches to UI layout personalization (EU, 2024; Valdez et al., 2024). This balance does not require excluding system involvement: personalization can still be user-driven even when aided by the system. For example, when the system suggests layout changes, but users retain decision-making control and the ability to further personalize the interface manually. In this context, a goal of this dissertation is to explore how user-driven personalization can empower users and grant them agency over UIs, allowing them to

take action and exert control over the interfaces they use. However, can these users be fully empowered if they lack the knowledge and data needed to make informed personalization decisions? This question highlights a gap we address in this chapter by studying balanced alternatives to system-driven solutions.

In this chapter, we explore the role of interaction data in supporting users' data-driven decision-making in user-driven UI personalization. We focus on efficiency-related data (e.g., click activity), as efficiency is users' primary personalization goal (Chapter 3).

Interaction data has long played a central role in how companies optimize their products (Google, 2024; Isaacs et al., 2014; Harbour, 2011; Kaur and Singh, 2015; Harty et al., 2021), yet it has typically remained inaccessible to end-users. In personalization, interaction data is often translated into high-level recommendations rather than presented directly to users. To the best of our knowledge, the potential of making interaction data available to personalization users has not yet been explored.

With the ultimate goal of informing the design of personalization software that empowers users to make informed, data-driven, decisions, we defined the following research questions (RQs):

(RQ1) *How do people engage with interaction data to identify and reflect on opportunities for UI personalization?*

(RQ2) *What are people's perceptions of the processes of collecting and analyzing interaction data for data-driven personalization, including its challenges and benefits?*

(RQ3) *How do people envision personalization solutions enabling access to interaction data, and what support do they expect for identifying opportunities, making decisions, and implementing changes?*

To answer these questions, we conducted a semi-structured interview study with 12 participants, employing experimental vignettes as design probes (Wallace et al., 2013; Barter and Renold, 1999) to elicit participants' perspectives on how they might engage with interaction data to identify and reflect on personalization opportunities. The vignettes presented four versions of *UIPulse* (a hypothetical platform) each illustrating a different way the software could support interaction data visualization and the personalization process.

In the remainder of this chapter, we present the study's methods and findings and discuss their implications.

The chapter contributes **design considerations for integrating interaction data with UI personalization (C5)**.
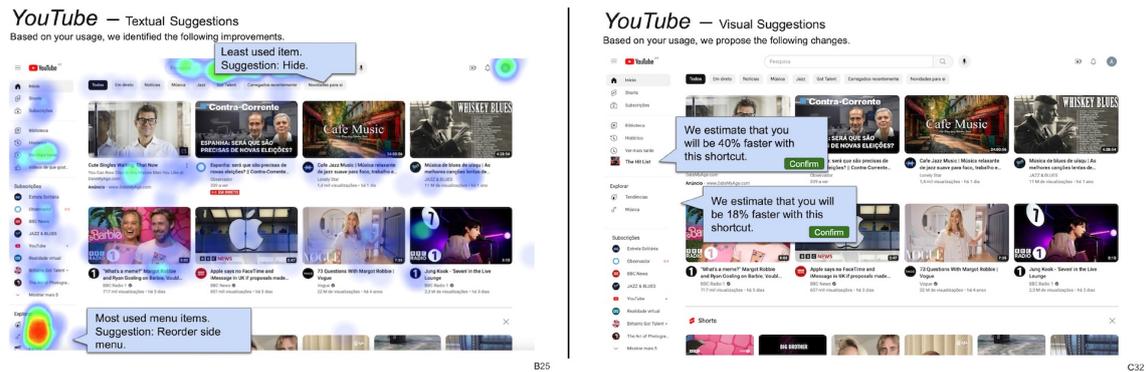
Figure 5.1: Two example vignettes illustrating two of the four scenarios in which a hypothetical platform leverages personal interaction data to support the identification and implementation of UI personalization opportunities. Each scenario was illustrated through multiple vignettes, which served as design probes to provoke participant reflection and discussion during the interviews. In these two illustrations, the hypothetical software supports decision-making by generating textual (left) or visual (right) personalization suggestions based on clickstream data. The left vignette shows the original UI overlaid with a click heatmap and textual suggestions (interpretations of the interaction data that highlight potential usability issues and recommend manual personalization actions). The right vignette, through a system-initiated design process, presents visual suggestions, where the system displays a preview of the personalized UI, which users can adopt and further refine, and includes estimated time savings. Similar benefit estimates are also present in other vignette scenarios. Both scenarios illustrate a workflow where users retain personalization control and can personalize their interfaces freely, following a user-driven strategy.

5.1 Materials and Methods

We conducted a semi-interview study using experimental vignettes as design probes. During the interview, participants consulted illustrated scenarios depicting interfaces that represent the digital behavior patterns of two personas to support smartphone and computer personalization.

Each of the four *UIPulse* versions was presented through a dedicated vignette set, each illustrating different methods of presenting and using the data to guide personalization. Version *A* presented raw data-only dashboards (data tables and heatmaps), allowing users to interpret and personalize without system assistance. Version *B* added textual prompts to support interpretation and help identify personalization opportunities (see Figure 5.1, left). Version *C* consisted of visual suggestions, offering visual mockups of proposed changes to support both data interpretation and personalization (see Figure 5.1, right). Finally, Version *D* focused on socially-informed suggestions, recommendations informed by users with similar behaviors (Hong et al., 2025).

The vignettes, developed solely for the interviews, used synthetic data and familiar UIs to help participants engage with the data and reflect on different levels of support for decision-making and personalization. This setup enabled discussion around various levels

of system support for personalization, including system-initiated design features (*Visual Suggestions*), cost-benefit trade-offs highlighting effort and time savings, and data-sharing comfort (*Social Suggestions*).

Our university's ethics committee reviewed and approved the research protocol. This section details our methodology, including the vignette development and procedure.

5.1.1   Goals and Methodological Approach

This study explored how users perceive the value of engaging with interaction data, not simply to automate personalization but to reflect on behaviors and identify UI improvements. We focused on the ideation and reflection processes rather than evaluating real-world task performance or efficiency gains, which are well documented in previous research (Wu et al., 2022; Reinecke and Bernstein, 2011). We investigated how participants envisioned the collection and use of interaction data, and whether they could move from passive viewing to identifying actionable personalization opportunities. To support this open-ended reflection and inform future design directions, we used speculative scenarios as design probes instead of a functional system.

Design probes are speculative artifacts or scenarios used in the design process to provoke reflection and discussion about future technologies or practices (Wallace et al., 2013). They help explore participant perceptions in unfamiliar or yet-to-exist contexts before developers commit to a specific design direction.

We used on-paper vignettes as design probes. Vignettes are short scenarios involving personas, objects, interfaces, or contexts of use (e.g., a story) and are well-established in qualitative research for eliciting in-depth perspectives and judgments (Peter M. Steiner, 2017; Finch, 1987; Baguley et al., 2022). Vignettes are commonly used alongside other data collection methods, such as interviews, observations, or surveys. We combined vignettes with interviews, an effective method for prompting discussion and contextualizing participant perspectives (Kandemir et al., 2018; Barter and Renold, 2000, 1999).

Compared to using functional systems, vignettes are more cost-effective, time-efficient, and flexible. They enable the discussion of multiple imaginative futuristic alternative solutions to the same problem without the constraints or bias of technical implementation. To support this, vignettes must provide sufficient context about the topic under discussion while remaining vague enough for participants to fill in the missing details (Chee Wei and Kian Yeik, 2022; Barter and Renold, 1999, 2000).

Vignettes can also ease recruitment by reducing confidentiality and privacy concerns present in more intrusive methods (Chee Wei and Kian Yeik, 2022). Rather than collecting participants' authentic interaction data, we constructed vignettes with synthetic data originating from UIs that participants were familiar with. This trade-off grounded discussion in familiar contexts while preserving privacy. While authentic interaction data might offer richer detail, synthetic examples can still enable valuable insights into how

participants interpret data and consider personalization opportunities.

When the topic is context-dependent, vignettes present concrete examples of people and their behavior (Hazel, 1995). Participants are then asked to respond based on what they or someone else might do in a given situation. To support this approach, we introduced two personas (Alex and Chris) to provide narrative and contextual grounding for how data could be collected and used (Hughes, 1998). This allowed us to frame synthetic data as belonging to the personas, making it easier to illustrate and discuss interaction data in scenarios where participants might have been reluctant to share real information (Sundar and Marathe, 2010), such as those involving social media platforms.

We were interested in studying how people interpret the data and make personalization decisions, which vignettes are well-suited to explore (Finch, 1987). While participants' responses may not necessarily reflect real-world behavior (Barter and Renold, 1999), this is less of a concern given our focus on studying interpretation and decision-making (Finch, 1987).

5.1.2 Vignette Design

We developed 42 vignettes, divided into four sets (*A – D*), with each set illustrating a different version of *UIPulse* (*A – D*). Starting with the story of Alex and Chris, participants explored each vignette set sequentially. Each set began with high-fidelity illustrations from the corresponding *UIPulse* version and ended with a reflection moment, a series of elicitation questions designed to gather participants' perspectives on that set. For each *UIPulse* version, that set of vignettes displayed interaction data from two applications: one fixed web application shown to all participants, and another individually selected web or mobile application tailored to each participant (based on web usage information they provided during recruitment and follow-up correspondence). Figure 5.2 illustrates the structure of our vignettes, which were informed by the work of Gray et al. (2017), including the development of personas and associated questions.

A pilot study involving two participants (P1 and P2) helped refine the materials by reducing the number of vignettes and questions to minimize cognitive load and potential participant fatigue. The vignettes and the interview script are available online[1] and in Appendix D.2.

5.1.2.1 Personas

We introduced two personas to ensure participants could relate to at least one, helping them engage with the context and feel comfortable expressing critical views, particularly on sensitive topics like privacy or data collection context. Alex and Chris are gender-neutral and differ in age, education, profession, digital literacy, and intention to use

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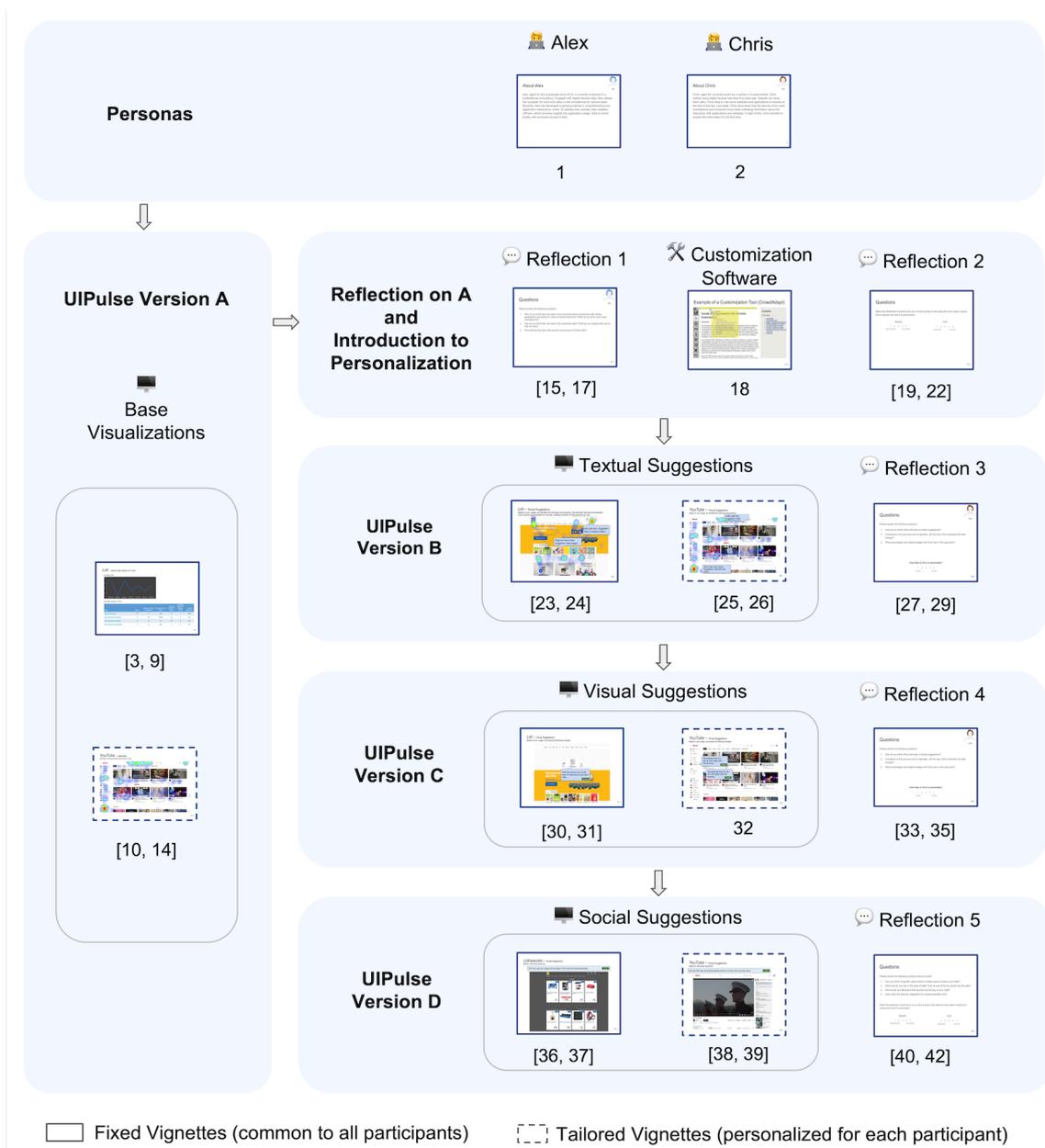[1]https://osf.io/8awdj/?view_only=9451ed14653b4a96857750ff9eeb9b3b

Figure 5.2: Structure of the four vignette sets used to support the interviews, where each set represents a different version of UIPulse. Each set consists of a series of vignettes, with their ranges indicated in square brackets. The sequence begins with the presentation of two personas, followed by Set *A*, which introduces a UIPulse version focused on data visualization dashboards (accessible across all sets). After reflecting on these dashboards, participants are introduced to the concept of personalization through a vignette illustrating a customization tool and invited to consider how interaction data might support personalization. Sets *B*, *C*, and *D* follow a similar structure, each featuring UIPulse illustrations that include both fixed vignettes and vignettes tailored individually for each participant, along with a reflection moment.

UIPulse, with Alex being tech-savvy and Chris non-tech-savvy. Below, we present the full descriptions of both personas:

Alex. *Alex, aged 32 and a graduate since 2014, is currently employed in a multinational consultancy. Engaged with digital devices daily, Alex utilizes the computer for work and relies on the smartphone for various tasks. Recently, Alex has developed a growing interest in comprehending how application interactions unfold. To address this curiosity, Alex installed UIPulse, which provides insights into application usage. Data is stored locally, with exclusive access to Alex.*

Chris. *Chris, aged 59, currently works as a cashier in a supermarket. Chris started using digital devices less than five years ago. Despite not using them often, Chris likes to visit some websites and applications of interest at the end of the day. Last week, Chris discovered that the devices Chris uses (smartphone and computer) have been collecting information about the interaction with applications and websites. In light of this, Chris decided to access this information for the first time.*

5.1.2.2 Designing Vignettes with Data from One Common and One Participant-Specific Application

To help participants ground their reflections in familiar contexts, each vignette set included vignettes with interaction data from two applications: one fixed across all participants, and one tailored to each individual.

The fixed application was the website of an international retail chain[2], which allows people to browse products and consult discount flyers. We included data from this application to ensure that at least one source provided sufficiently complex and engaging interaction data.

We selected the tailored application based on a preliminary questionnaire, where participants listed three applications or websites they frequently used. From these, we chose the one most likely to provide meaningful interaction patterns and personalization opportunities, often a social media, news, or entertainment platform like *YouTube* (Appendix D.3).

We defined specific vignette slots for presenting data from both applications, ensuring a consistent placement for all participants (as shown in Figure 5.2). To simplify, we assumed Alex and Chris interact with these applications similarly, allowing us to reuse the same vignettes for both personas.

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[2]https://www.lidl.com

5.1.2.3   High-fidelity Illustrations of UIPulse

The four illustrated *UIPulse* versions depict distinct approaches to supporting personalization decision-making. Each scenario was designed to vary along key design dimensions known to influence engagement with personalization systems, namely the senses of effort, privacy, control, and identity (Sundar, 2008; Marathe and Sundar, 2011; Bunt et al., 2007a; Peissner and Edlin-White, 2013; Sundar and Marathe, 2010). These dimensions have been balanced through personalization suggestions (Bunt et al., 2007b, 2009) or, as explored in Chapter 4, community-based mechanisms for social support.

In our vignettes, we reframed these strategies from a user-driven perspective. Instead of focusing on how system-driven approaches could benefit from interaction data (e.g., improved explainability of system decisions), we reimagined them as ways to support user decision-making within a user-driven personalization process informed by interaction data. For example, in a low-effort condition (set *C*), the vignettes present a *UIPulse* version that guides users through the interpretation of data and the initiation of personalization actions (using visual suggestions), representing a user-driven personalization strategy guided by system-initiated design considerations.

Users have access to the data dashboards (set *A*) and manual UI customization software across all scenarios. Table 5.1 summarizes key differences across scenarios.

Table 5.1: *UIPulse* scenarios ("Pers." = Personalization). Across all scenarios, users control the personalization process, with access to the base data-only dashboards (set *A*) and a manual UI customization software. The scenarios differ regarding design initiative, the presence of cost-benefit estimates (e.g., time-saving trade-offs), and the scope of data analysis. *B* supports only the interpretation of data through textual suggestions; *C* and *D* support both interpretation and execution via pre-configured UI changes (i.e., system-initiated design). *A–C* provide tailored solutions unique to each user, while *D* introduces socially-informed suggestions based on behavioral patterns shared across users.

Scenario	Pers. Control	Design Initiative	Cost–Benefit Estimates	Data Analysis Scope
Base Visualization Dashboards (*A*)	User-driven	User-initiated	—	None (Data only)
Base & Textual Suggestions (*A + B*)	User-driven	User-initiated	✓	Local
Base & Visual Suggestions (*A + C*)	User-driven	System-initiated	✓	Local
Base & Social Suggestions (*A + D*)	User-driven	System-initiated	✓	Socially-Informed

The four sets are characterized by the following features:

(A) *Base Data-Only Visualization Dashboards.* Set *A* begins with screen time data (inspired by macOS Screen Time (Apple Inc., 2024b)) to introduce participants to
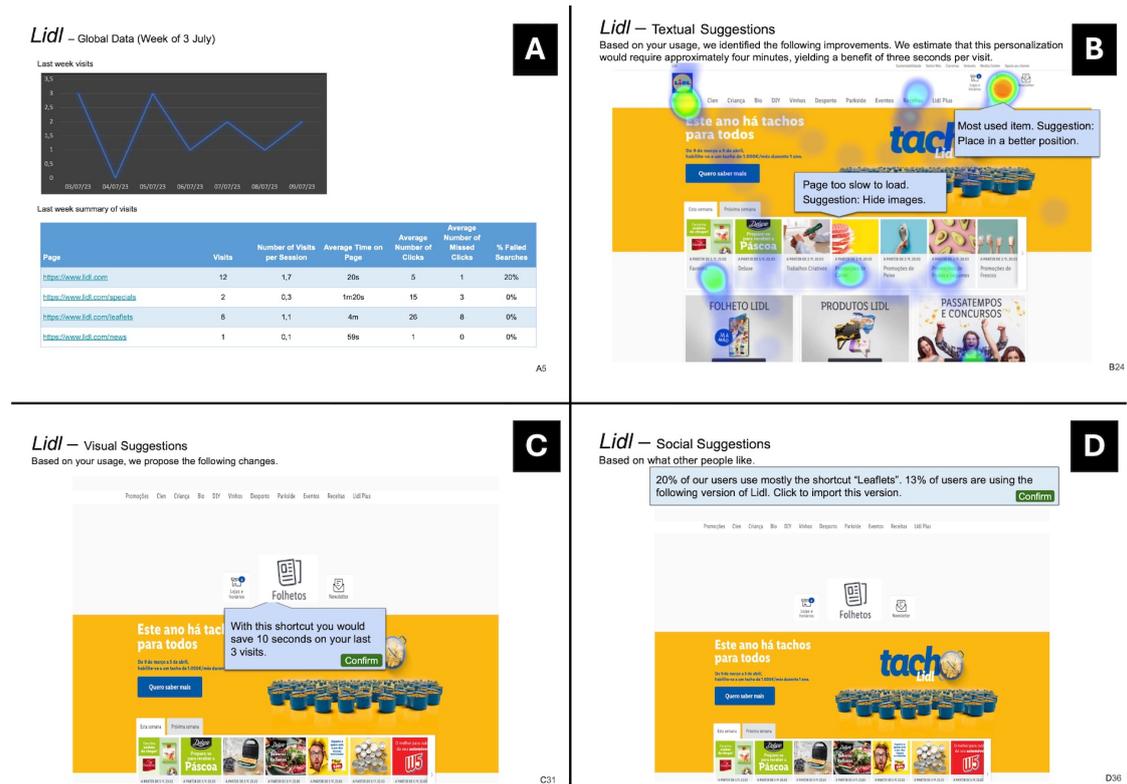
Figure 5.3: Example vignettes from each of the four *UIPulse* sets. Each vignette includes a title (combining the vignette name with the title of the analyzed UI) and a brief description.

Alex and Chris. It then presents clickstream data for two selected applications, using both numerical metrics (e.g., visit counts, average time per UI; Figure 5.3 A) and visualizations like click and scroll heatmaps (similar to Figure 5.1, left, but without suggestions), highlighting frequently used UI elements and sections.

These dashboards, designed following standard practices for visualizing usability, clickstream, and traffic data (Gupta and Rawat, 2016; Crazy Egg, 2024; DugWood, 2024; Chi, 2002; Google, 2024; PRO, 2024), are available in all *UIPulse* sets, enabling users to consult their interaction data regardless of the scenario. We created click heatmaps using an online drag and drop fake heatmap generator[3].

Additionally, this set includes an illustration of a customization tool (*GitUI*). This aims to clarify the concept of personalization by providing concrete examples of actionable interface modifications.

(B) *Textual Personalization Suggestions.* Set *A* visualizations are presented alongside personalization suggestions with a rationale for manual implementation (Figure 5.3 B). *UIPulse* presents these suggestions through pop-up messages. For example, a

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[3]http://robertivan.com/fakeHeatMap.html

message might state: "*Most used item. Suggestion: Place in a better position*".

UIPulse also presents cost-benefit messages with estimates regarding time savings and the duration of the personalization process, similar to mixed-initiative systems (Bunt et al., 2007b, 2009): "*We estimate that this personalization would require approximately four minutes, yielding a benefit of three seconds per visit.*".

(C) *Visual Personalization Suggestions.* The vignettes display visual suggestions, pre-configured UI modifications that users can accept (Figure 5.3 C), accompanied by a rationale and a cost-benefit message. An example is: "*We estimate that you will be 20% faster with this shortcut. Click to confirm.*". This approach draws on system-driven approaches (Kühme, 1993; Jameson, 2007; Liu et al., 2024; Wu et al., 2022), where UIs adapt automatically.

(D) *Social Personalization Suggestions. UIPulse* offers socially-informed suggestions (Figure 5.3 D) in the form of community-based templates, suggested according to behavioral patterns shared with similar users. This reflects a common content personalization practice, where social recommender systems leverage social information to guide tailored suggestions (Hong et al., 2025). We introduced this set to explore participants' comfort with the data-sharing and analysis practices required to generate such recommendations. It also supported discussions on whether participants would find value in accessing aesthetic-related data and suggestions. An example is: "*30% of our users are unhappy with the design. Click to import the following alternative*".

Participants were asked to visualize the vignettes sequentially, following the reference number presented at the bottom of each vignette. We wanted participants to experience the personalization features progressively, allowing them to share any unconventional opportunities for using interaction data before being exposed to the additional capabilities introduced in later sets. In that sense, to assess whether participants could intuitively consider personalization as a potential use for the data, we avoided any explicit mention of personalization until the end of set *A*. Until then, the vignettes presented interaction data without any reference to personalization, leaving this interpretation open to participants. We followed this approach to assess whether participants could intuitively consider personalization as a potential use for the data.

5.1.2.4   Reflection Moments

The vignettes support five reflection moments (*Reflection 1–5* in Figure 5.2), each typically consisting of three vignettes accompanied by questions about the data and the software. The first two vignettes of each moment ask participants to speculate about the personas' behaviors with that version of *UIPulse*, using the personas as provocations to

prompt critical reflection. The third vignette then shifts the focus to the participant, inviting them to clarify or expand on their own perspective.

Set *A*, exceptionally, includes two reflection moments: the first focused on the general utility of interaction data, and the second on its potential for supporting UI personalization. *Reflection 1* (following the *Data-Only Visualization Dashboards* illustrations) explores participants' views on the personas' context, concerns, and motivations for using *UIPulse*, followed by questions about participants' own attitudes toward monitoring digital interactions, data utility, and privacy. This moment is followed by a vignette illustrating *GitUI*. Immediately afterward, the second reflection moment shifts the discussion to personalization. It prompts participants to consider what data might be important or missing for supporting meaningful personalization, and how Alex and Chris could improve their interactions.

The remaining three moments (*Reflection 3–5*) follow a similar structure. After each set, participants are invited to reflect on the personas' reactions to the *UIPulse* features illustrated, how those features might influence data interpretation, and the perceived advantages and disadvantages compared to previous sets. In the last step of each moment, participants rate on four scales (1 to 5) the likelihood of (1) Alex and (2) Chris personalizing their UIs and (3) the benefit (4) and effort they expect of analyzing the data and personalizing with the features available in that set. We used these scales to encourage discussion rather than to analyze their numeric answers.

The last reflection moment (*Reflection 5*) also explores potential privacy concerns related to social suggestions, along with general impressions of the study, particularly any perceived data gaps and alternatives for integrating interaction data into personalization.

5.1.3   Participants and Recruitment

We disseminated the study using university mailing lists, social media platforms, and by re-contacting individuals who had participated in previous studies on UI personalization. To be eligible, participants had to be internet users for more than four hours per week. Participants received a €10 gift card in appreciation of their participation.

We recruited participants with different expertise (education and technological proficiency) and demographic profiles (e.g., age and background). In total, 12 participants (P1 – P12) concluded the study (Table 5.2). Participants age varied between 26 and 60 years (33.4±10.3 years). Six identified themselves as men (50%) and six as women (50%). Participants usually spend 9.3±2.1 [7.5 – 15] hours a day using a computer and 3±1.5 [1 – 6] hours a day using a smartphone. They came from various educational and professional backgrounds, including healthcare, design, computer science, and economics. Six participants (50%) were experts (defined as those with experience in UI design or development) while the other six (50%) were regular users without such expertise.

Table 5.2: Participant profiles by ID, age, expertise (professional UI design/development experience), daily digital activity (total hours a day using a smartphone and computer), and UI personalization experience, indicating prior participation in studies related to personalization.

ID	Age	UI Design/Development Expertise	Daily Digital Activity (hours)	UI Personalization Experience
P1	29	✓	13	—
P2	29	✓	13	✓
P3	26	✓	19	—
P4	27	✓	12	—
P5	26	✓	14	✓
P6	48	—	11	—
P7	29	—	14	—
P8	60	—	10	✓
P9	29	—	9	—
P10	32	✓	13	✓
P11	30	—	10	—
P12	36	—	10	✓

5.1.4   Procedure

We conducted individual semi-structured interviews supported by the printed vignettes. Each session took place in a private room at the university and lasted on average 93.8±27.2 minutes, with short breaks at key moments.

We first collected informed consent and explained that the purpose of the session was to understand their perception of an interaction data collection and visualization platform. We then handed participants the first set of vignettes. We asked them to read the vignettes and express their thoughts. We handed out the sets of vignettes one at a time, with participants unaware of the next set's content, as there was a feature dependency between sets. Participants consulted the vignettes fluidly, often spending less than a minute on each and revisiting them as needed throughout the session.

The five reflection moments embedded in the vignette structure served as prompts to guide the semi-structured interviews. During each moment, the researcher read aloud and explained the associated questions, encouraged open discussion, and asked follow-up questions based on participants' responses. Throughout the session, the researcher also paid attention to participants' comments and body language to probe further into their reasoning and perspectives. The session script is available in Appendix D.1.

5.1.5   Analysis

Three researchers analyzed the audio-recorded interviews. We performed a thematic analysis (Braun and Clarke, 2006) while following the first three stages outlined by Halcomb

and Davidson (2006), which do not require complete transcription of interview recordings. First, one researcher took notes of relevant phrases, recurring ideas, and non-verbal cues during all interviews. After each interview, the researcher reviewed and expanded the notes. At the end of the study, the same researcher performed intelligent verbatim transcription by carefully listening to all audio recordings and selectively transcribing participant responses, excluding filler words or off-topic conversations. Given the semi-structured nature of the interviews, the resulting transcripts and notes were organized under thematic headings aligned with the interview questions, ensuring an accurate and coherent representation of participants' perspectives.

Next, in a group session, three researchers discussed and analyzed a sample of three (25%) interview transcripts. This initial review served to identify recurring themes, patterns, and insights. The team collaboratively constructed an affinity diagram to identify and connect emerging themes and group similar ideas. From this process, we developed a codebook that captured key themes and sub-themes reflecting participants' views on interaction data and personalization. One researcher used the codebook to code, reflect, and analyze all the transcripts. The research team iteratively discussed and refined themes for writing. Next, we present our findings, organized according to the identified themes and supported by relevant quotes and examples from the coded interviews.

5.2   Results

In this section, we describe participants' reactions to each set of vignettes and how they engaged with the data to identify personalization opportunities. Then, we outline how they used interaction data to justify personalizing and their requirements for integrating it with the personalization process. We conclude by presenting participants' perceptions of the general interaction data monitoring process.

Overall, participants' reactions to the personas varied depending on the specific situation or concept under discussion. After discussing how the personas would react to the various scenarios, most participants alternated between relating themselves to their perceived behavior of Alex and Chris. They also valued analyzing the data from the tailored vignettes, as it facilitated their understanding of the context and benefits. Most participants attributed a gender to Alex and Chris, which is noticeable in some quotes we present.

5.2.1   Identifying Personalization Opportunities

This section details how participants utilized each set of vignettes to uncover personalization opportunities.

5.2.1.1 Personalization Opportunities Arising from Data-Only Dashboards

Most participants (except P3, P8, and P9) intuitively and independently considered personalization opportunities without requiring system support for interpretation, relying solely on the dashboards of the set *A* and a brief description of a customization tool. The UI opportunities they identified include "*creating shortcuts to increase tasks agility*" (P4), "*opening websites automatically in the most used webpage*" (P10), or "*better position the most clicked elements*" (P11).

Notably, P7, despite having no prior experience with UI personalization, was the fastest participant to identify improvement opportunities, demonstrating the potential intuitiveness of the process. P7 related to the vignettes, stating: "*I never visit the 'Hobbies' and 'Competitions' [two sections of the fixed UIs]. I would move them down and highlight the 'Recipes'*".

Participants often contrasted their experiences with and without access to interaction data. For example, P5 emphasized how such data could have improved his past personalization efforts: "*I have previously used a personalization platform, and it was difficult to understand exactly the ideal arrangement for the UI elements. If I had access to these heatmaps, I could understand which buttons I access the most and distribute them more efficiently*".

The participants unable to identify UI improvements approached the first set of vignettes with a different mindset, focusing on using the data to change their behavior and adapt themselves to the UIs rather than tailoring the UIs.

Exposing Interaction Routines. **Click and scroll heatmaps** emerged as the primary source for supporting the discovery of personalization opportunities, with participants highlighting their general preference for visual data dashboards: "*Click heatmaps are particularly interesting as they show where Alex clicks... also scroll heatmaps can support users in reorganizing the UI. If Alex constantly scrolls to the bottom, he may want to move the content to the top*" (P7). The feedback of P12, with personalization experience, was also encouraging:

> "*One of the difficulties I encountered in my previous customization experiences was: 'What am I going to customize?' Heatmaps can be a good starting point for people to understand what UI elements they use most and should highlight*".

Obstacles to Data Analysis. Participants expected benefits of accessing their personal interaction data and personalizing, but most assumed lacking the confidence to use the data for personalizing actively. The most common obstacle was the anticipated effort involved, with some participants concerned about the analysis effort and others with the implementation effort.

Participants also highlighted that identifying personalization opportunities can trigger a desire to personalize but not strong enough to actually do it:

> *"There might be an intention to personalize, but not everyone will see its value or be available.... 90% of people are not interested... I belong to the other 10%, although it would be very* **challenging to customize without understanding which elements to adjust and recognizing interaction problems**" (P5).

Expectancy for Support.   To increase the probability of personalizing, **participants expected system support regarding personalization decisions**: *"I would prefer a tool that presents this data together with personalization suggestions that I could select"* (P5). P12 also highlighted the importance of system support in simplifying data analysis and implementation efforts: *"Personalization guidelines (i.e., instructions) would be great, even if I were ultimately the responsible for customizing... I would not need to analyze data. The instructions could include components like color or size that would allow me to reflect: 'Do I want to do this or not?'"*.

The need for system support was noticeable in the comments of P2 and P10, who did not even consider personalization opportunities requiring manual implementation but straightforwardly identified opportunities for more automated processes (e.g., manual confirmation to automatic reorder of elements). P2 highlighted that users would need guidance in designing alternative UIs (*"The vignettes provide data but not present solutions to improve [the UI], people will not personalize"*), and P10 described how a system should facilitate personalization implementation: *"The system should immediately suggest: 'These are your usage patterns. Would you like us to make this change?'"*.

5.2.1.2   Assisted Personalization Decision-Making

Most participants, even those who independently identified opportunities, highlighted the value of personalization suggestions of sets *B* and *C*, especially as the vignettes spotlighted personalization opportunities they missed before. Therefore, participants **reacted naturally** (considering the previous comments) **and with excitement to the textual and visual suggestions**: *"I like this (set B). It is really useful because it brings the two things together (data and personalization). It makes sense because once the data is collected, it is easy to have these suggestions"* (P7). For participants, suggestions can hold particular value for non-experts, such as P9: *"We often know what we use or like in UIs, but it is difficult for a common user, like me, to imagine how UIs can be improved"*.

Textual Suggestions.   Participants frequently expressed their agreement with the suggestions as they read them e.g., *"'Highlight the element.' Exactly... Next"* (P6), reflected on how implementing the suggestions can impact interactions, or considered alternative

ways to implement them. For example, P9 suggested, "*Alternatively I could place this shortcut on the home page*".

Overall, participants highlighted **time-saving advantages by having their "*data immediately translated*"** (P11). However, they still **expected support for implementing suggestions**, as highlighted by P10: "*The system suggests it, but does not implement it for you? It does not sound as good. It should have a suggestion and its preview*".

Visual Suggestions. **Visual suggestions were the favorite concept for participants**, as it was when visualizing them that they most fully appreciated the personalization concept. For P7, these suggestions represented a turning point in embracing personalization, noting that "*This one (Set C) brings it all together... it has to be this*".

Participants considered the downsides of visual suggestions minimal as long as they maintained control over personalization decisions. These downsides included situations where participants did not relate to the suggestions, questioned their relevance, or found them visually unappealing. As P6 explained: "*There are opportunities I can identify independently and suggestions I do not like... but I have the option to accept or reject*". This intention to exert control extends to their willingness to personalize the visual suggestions further, as P9 expressed: "*On the popup there could be the option 'Confirm' or 'Keep Personalizing'*".

Suggestions, especially with visual cues, can serve as **triggers for personalizing**: "*As Alex and Chris do not have to make the changes, just confirm, they will be more proactive and customize more*" (P4). Participants outlined the advantages of visual suggestions compared with sets *A* and *B*, as P4 exemplified: "*These suggestions are a customization prompt. People will immediately feel prompted to use the system. While the other (set A) satisfies curiosity about habits, these suggestions encourage reflecting on efficiency and personalization*".

5.2.1.3   Social Personalization

Participants received social suggestions with caution, identifying opportunities mainly related to **aesthetics**. For instance, P5 noted: "*These suggestions do not relate to me, but I think Alex will find them interesting for having alternative aesthetics* ". For P5, having the "*community establishing the most pleasant aesthetic*" makes sense. Participants also recognized the value of social suggestions for "*instantly (i.e., before data collection) accessing personalized UIs*" (P11) and supporting users without "*patience*" (P8) to personalize. Simultaneously, participants believe these suggestions can encourage users to experiment with different UIs, ultimately leading to adapting one's taste and greater awareness of UI elements susceptible to personalization.

Social components can still support the identification of personalization opportunities in several ways. For example, they can draw attention to **social tendencies**, as illustrated

by P4, who imagined a typical reaction: "*Everyone is using this, let me try it*". They can also **increase awareness of previously unnoticed UI elements**, with P12, for instance, expressing surprise by noting, "*I did not know there was a box here*". In addition, they can enable **social comparisons**, which can ultimately shape how people interpret their data, as P5 explained: "*If someone takes longer (to perform a task) compared to the community, it can indicate a problem*".

However, when social suggestions focused on efficiency, many participants reacted negatively. This approach heightened privacy concerns and reduced the perceived sense of individualization arising from the changes, two concerns we will detail later.

5.2.1.4 Promoting Identification of Personalization Opportunities

An indirect benefit of facilitating the identification of personalization opportunities can be the promotion of proactive personalization. Participants' mentality and intentions to personalize changed as they progressed through the vignettes, particularly with the suggestions. For P4, **"*suggestions trigger the first personalization step*" and spark an intention of personalizing beyond the initial suggestion**. Even visual suggestions, requiring only users' confirmation, can stimulate users to manually customize: "*Visual suggestions would be fantastic... It promotes more active personalization, with users able to start personalizing themselves*" (P12).

The most noticeable positive impact of suggestions was people's **"*mindset change*"** (P6), resulting in the "*acceptance that personalization is possible and improves UIs*" (P6). Particularly, there was a change in people's vision towards their agency over UIs, as demonstrated by P7:

> "*The average citizen assumes UIs belong to their creators. The future is like this. Just as social media profiles reflect ourselves, why should not the websites we frequent also reflect a bit of who we are?*"

A mental change was also visible when people speculated on **extrapolating specific suggestions or opportunities to other contexts and UIs**, as P8 mentioned: "*Alex will understand that he can change more things on every website he visits*". Ultimately, participants started understanding beneficial personalization opportunities without accessing the data or suggestions.

Simultaneously, this mindset shift can encourage greater self-awareness (i.e., users' intentions to understand their own behaviors and interactions): "*This setup gives me a feeling of belonging and ownership. I feel this is my website... I can start understanding the suggestions and increasing awareness about my use and, instead of waiting for suggestions, I can start making suggestions*" (P12).

5.2.1.5   Overcoming Challenges in Identifying Personalization Opportunities

Some participants occasionally faced challenges identifying personalization opportunities, which they gradually overcame as they progressed through the vignettes.

Before participants were informed that the study focused on personalization, most struggled to connect the data to personalization. These challenges stemmed mainly from their **initial agency perspective over UIs and personalization**, where participants did not envision they could adapt the UIs they use. P3 was one of those participants: "*I do not know what I will do with this data. I have no objective, just to see it*".

Within set *A* and the personalization context, some participants struggled to **distinguish between the correct use of a UI** (i.e., using UIs as intended by its designers) **and the optimal use**, which prioritizes efficiency. For instance, P2 focused more on finding interaction problems or incorrect uses of UIs rather than UI improvements: "*Alex is using UIs correctly. I think his interactions are not bad, so there is nothing to improve*". P12, uncertain about her personalization needs, acknowledged challenges in interpreting the data, even though she had previously identified personalization opportunities. P12 highlighted her challenges in interpreting the data, noting that the textual suggestions facilitated the process: "*Suggestions reduced the work and frustration of looking at data I do not understand... It is difficult to understand what the data indicates about my usage? Is it good or bad? I should not have to understand heatmaps and suggestions guide me*". P2, instead, needed visual solutions to understand personalization benefits, as verbal suggestions were insufficient: "*suggestions [B] are useless because it is the right way to use the UI. It does not present any problems... Accessing a non-optimized and optimized way to use the UI would help to understand suggestions benefits*".

Participants assumed that their **routine actions** or **unconscious interactions** with some UIs could make it challenging to distinguish between correct and optimal use and create moments for reflecting on potential improvements. P3 describes these interactions as part of a "*zombie mode*" but assumes that accessing interaction data can make him reflect and analyze his actions while in this mode. In the end, **existing routines did not challenge identifying personalization opportunities but rather the perceived benefits and efforts of personalizing**, which we describe next.

5.2.2   Decision-Making Factors

After participants identified a personalization opportunity, various factors shaped their perception of how likely they would be to personalize. In this context, **accessing interaction data and cost-benefit estimates can be crucial in motivating the personalization step**. Participants emphasized that for people to personalize a UI, they must first recognize it will lead to tangible improvements, as P10 emphasized: "*Suggestions would help me know what to change. Then, it would depend on how willing I would be to change. I*

customized UIs before... but never felt it made a difference".

5.2.2.1 Personalization Trade-Offs

Although vignettes included messages estimating the cost and benefit of specific personalizations, participants considered decision-making factors beyond these messages and insights. We outline the various trade-offs they weighed when reflecting on the benefits and drawbacks of implementing an identified opportunity.

Cost-Benefit Reflections. Before accessing the cost-benefit messages, participants struggled to identify the practical benefits of personalizing, as exemplified by P5: "*I can not estimate the benefit or how many seconds I would gain with this personalization. I would need that data to be sure*". The introduction of the cost-benefit messages supported this process and also encouraged participants to reflect on other details. For instance, one common first step in evaluating the benefits was consulting the time spent on each application (the screen time data of set *A*), with more frequent usage correlating to a higher personalization probability.

People can still accept suggestions for the less used UIs but with less expectation of benefits: "*Alex will accept suggestions, especially on YouTube, which he uses the most. Alex can accept the suggestions for the other applications but only because it is useful*" (P4). In that regard, participants suggested cost-benefit messages should account for usage frequency and present monthly time savings to facilitate benefits assessment: "*Three seconds for a visit does not sound too good unless you go there five times a day...*" (P4).

Additionally, in manual personalization contexts, **cost-benefit metrics can help users plan their personalization efforts** by providing estimates of the time and effort required: "*You can create a plan*" (P1). According to participants, these metrics will also encourage users to accept visual suggestions: "*The probability of personalizing is a five. Alex knows how much time he will save and how much he will be faster*" (P9).

Regarding effort metrics, most participants found them useful, though P12 felt they could discourage personalization: "*This four-minute estimation is counterproductive. Instead, perhaps it should indicate the steps to implement these changes*".

Ultimately, **accessing cost-benefit metrics can contribute to an increased sense of agency**, by supporting people to decide what is worth personalizing, as suggested by P5: "*By knowing the benefit of customizing each UI, I can select which UIs I customize and its benefits would be higher*".

Routines Disruption and Learning Curve. Participants consistently reflected on how changing a UI would affect personal routines and the effort needed to adapt themselves to the personalized UIs. Ultimately, some believed such changes could initially introduce inefficiencies: "*Would not moving an element to a new place worsen the performance?*

Personalize for reducing the number of clicks is good, but switching elements is not"
(P2); "*You may think you will be faster, but you will not be faster initially because you are already used to it*" (P4).

For participants, suggestions and cost-benefit metrics can be crucial in helping users feel confident in creating new routines. For instance, P5 believes people "*need to ensure personalizing will increase efficiency*". P12 argues suggestions "*raise awareness of personalization benefits; and clarify the rationale for changing certain elements, which otherwise would conflict with users' mental map of UIs*".

Social Validation. Participants viewed social components as a form of "*social validation*" (P8) for personalized UIs, helping to confirm if they are "*user-friendly*" (P7). They also believed that social components could highlight community trends, though their opinions on their value vary. Some expressed skepticism, with P7 remarking, "*It seems designed for the sheeple*", while others saw these influences more positively. For example, P6 likened them to fashion trends: "*It is like a nice piece of clothing that I would want to try*".

Comfort. Participants found their perceived personalization benefits crucial for deciding to personalize. In that regard, above all, they expected more comfort interacting with UIs, which involves having **simpler UIs that support efficient navigation while keeping a pleasant aesthetic**. P6 exemplified: "*When you use a UI frequently, you want to feel as comfortable as possible. It is worth changing to feel more comfortable, like creating a cozy home space*".

5.2.2.2   Independent Data Analysis and Reflection

Participants commented that lacking trust in data and suggestions could hinder people's personalization intentions. To build this trust, it is essential to **ensure transparency and support for independent data analysis**, enabling users to make informed decisions on their own. Most participants expressed a desire to review the data themselves in order to validate and understand the suggestions, as P4 explained: "*I like to confirm the information and make sure I am making the right decision*". The exception was P7, who confessed only needing to understand the benefits through the cost-benefits messages.

Participants also considered analyzing the data important in situations where users can understand their behavior better than software. For instance, P3 noted that users often engage with UI elements unconsciously (e.g., selecting text for highlighting it while reading), emphasizing that not all interactions are meaningful for personalization.

5.2.2.3   Moderate Magnitude of Change

To optimally support personalization, participants emphasized the need for a "***gradual personalization pipeline***" (P1), which involves analyzing **data**, **suggestions**, and **social trends**: "*I access the suggestions, then I need to know the general usefulness for people who already accepted them and for myself*" (P1). P12 also connected these three steps, believing utilizing suggestions can create personalization habits, leading people to value more personalization and the social components.

A moderate personalization progress can also work as a trust-building mechanism. For instance, P6 noted that people should go through **progressive stages**, testing each UI change and recognizing its benefits. By doing so, users can gain confidence in the system and its subsequent suggestions. Similarly, P10 emphasized that initial suggestions should be more subtle: "*The first suggestions need to have a high degree of certainty and be less visually disruptive*". P10 suggests implementing suggestions as a "*tip of the day*": "*I use a personalized UI for a few days, and when I get used to it, I can get a new personalization tip*".

5.2.3   Implementing UI Personalization

Participants identified vital requirements for the data collection, visualization, and personalization processes.

Control.   The most important requirement regards control, including **controlling the data collection process, data sharing, personalization decisions, and the personalized UI**. Participants emphasized the importance of the **malleability of personalization**, such as "*revert options*" (P6), "*personalization previews*" (P3, P10), or the ability to "*further customize UIs resulting from accepted suggestions*" (P5). This sense of control was further reinforced by participants' desire to access and interpret the data informing suggestions, as presented earlier. Participants believed that being able to reflect on their data to make informed personalization decisions independently can foster a feeling of empowerment and make personalization feel more user-driven.

Individualization.   For most participants, the key can include balancing a sense of control with feelings of "*individualization*" (P11), "*belonging*" (P7), and "*appropriation*" (P12). Participants believe these emotions can emerge when users control the personalization process and the resulting UI feels unique and shaped by their "*personal choice*" (P7). For instance, they expect benefits from accessing UIs personalized by the community but highlighted they "*are not individual*" (P7). P11 was one of those participants: "*If the UI is personalized based on other people's data, it is no longer yours nor made for you*". Nevertheless, installing a community-based personalization template can also be

a personal choice incorporating some degree of individualization and control: "*Multiple templates can be presented, and I decide. It would look more personal than presenting only one template the community uses*" (P7).

Aesthetics   While participants did not prioritize aesthetics, it is crucial for them that the personalized UIs maintain an appealing visual experience: "*If the suggestion ruins the look, I do not think it will be accepted. I think people prefer to be less efficient and use something more visually appealing*" (P10). Visually unpleasant UIs can "*feel like a bug and be a clue for future problems*" (P10), or compromise the perceived benefits: "*For particularly unappealing or unconventional personalized UIs, I would have to reconsider whether the benefits are worth it*" (P5). Overall, there is a preference for more subtle changes, compromising neither the learning curve nor the aesthetics: "*This suggestion seems good. Looks generic. It looks like it is the website suggesting: 'We have this new UI, do you want to try it?'*" (P10).

Data Requirements for Meaningful Personalization.   Overall, participants believed the presented data "*complements well*" (P5) a personalization tool, highlighting the importance of "*complementing the visual perspective (e.g., heatmaps or charts) with a more quantitative one (e.g., tables)*" (P3).

Regarding missing data, P3 recommended including frequent navigation actions between different websites and information about multitasking (e.g., browser tabs frequently active simultaneously), which he expects to use to streamline workflows. P4 suggested incorporating zoom-in/out data to assess font-size adequacy, and P5 wanted to understand the time between clicks. Others, like P10, emphasized the need to interpret the semantics of interactions, noting that currently only the coordinates of the interactions (X and Y) are being collected.

Participants also proposed several ways to enhance data visualizations: (1) allowing heatmaps to be overlaid on the original UI; (2) clearly highlighting personalized elements in visual suggestions; and (3) improving the interpretability of scroll heatmaps, which some initially found confusing.

5.2.4   Motivations, Challenges, and Benefits of Interaction Data Monitoring

In this section, we report participants' initial response to the vignettes, a period in which they were unaware of our personalization intentions. These reactions represent additional motivations and challenges to monitor their interactions.

Five (P4, P5, P6, P7, P9) participants confessed a prior interest in monitoring their online behavior, primarily to gain insights, control themselves, and better manage their routines. The others expressed a lack of interest, in part resulting from the lack of options

to act on the data, as P1 highlighted: *"If I could personalize maybe I would consider monitoring myself"*.

5.2.4.1   Motivations and Expected Benefits of Data Monitoring

Initially, only P5 associated interactions monitoring with personalization. Participants' primary motivations for accessing interaction data related with efficiency in interactions, health, self-awareness, and curiosity. They anticipated **efficiency and health improvements through behavior change**, i.e., changing their behavior rather than the UI. These motivations were often associated with personal experimentation, with participants expecting to compare health symptoms (e.g., fatigue) and work productivity with the data.

Participants aim to enhance their **digital behavior awareness**, seeing value in a **reflection period** to question their habits, as P3 exemplified: *"Why I do not click here more often?"*. They believed such reflection could reveal navigation in *"zombie mode"* (P9), uncover unnoticed digital preferences or patterns, open navigation perspective to other opportunities – *"I would explore other interests"* (P3) – and ultimately support improved time management.

Additionally, they expect greater awareness of the data collected by other software they use. For many participants, **accessing interaction data can bring existing third-party data collection into the foreground, making it less opaque**. P4 is an example: *"Companies also collect this data. Visualizing it provides greater security, at least to be aware of what and how data is being collected"*. Still, P3 prefers to remain unaware of this data, as he is concerned with the consequences of gaining awareness: *"I would see what data companies take from me, but sometimes, I prefer to remain unaware... Alex might be shocked and scared after realizing they know everything"*.

Interaction data also offers opportunities to **support social sharing and reflection**, with P7 and P10 expressing interest in sharing their usage patterns: *"You could share this data, like 'This was my day'"* (P10). P7 compared it to sharing music on Spotify, suggesting, *"Maybe I would share how I use my smartphone"*. Such sharing could foster a sense of community around personalization practices and encourage engagement through mutual inspiration and comparisons.

5.2.4.2   Challenges and Barriers to Data Monitoring

Participants were initially uninterested or skeptical about the possibility of monitoring their interactions. They expressed concerns about the **effort and time** required to analyze the data, emphasizing the need for an optional analysis step. Many also felt they already had a certain level of **self-awareness** regarding their interactions, and that gaining deeper awareness could sometimes have adverse effects. These included anxiety upon realizing their behavior was not optimized (P10) or disappointment when becoming aware of certain personal routines (P8).

5.2.4.3   Privacy Perceptions

UIPulse can result in both benefits and challenges related to privacy. Five participants (P2, P3, P8, P11, P12) expressed privacy concerns. However, P3 was the only one assuming privacy as a barrier to installing *UIPulse*, preferring personalization software that does not collect personal data. For most, privacy was a secondary concern as long as the **data proves beneficial** (e.g., when suggestions clearly demonstrate added value) and they **retain control** over: (1) when and where data is collected (such as limiting it to certain websites or time frames), (2) what data is collected and stored, and (3) how it is used, including giving consent to its use. P7 summarized the general sentiment: "*I think this system is completely contrary to what is private. When you read a book, no one knows which page you read the most... However, if data is used to benefit me, security is a tertiary issue*".

Ultimately, the most important is to trust how data is being used. To this end, **transparency** can be crucial. For example, participants' perception of security improved as they understood why data could be collected and had the opportunity to visualize it. Personalization suggestions were also particularly reassuring, with P6 highlighting their importance in "*making clearer how the system uses the data*" and showing that "*it is trying to help*".

On the negative side, the social components generated greater concerns, mainly related to **data disclosure fears**. Aesthetics-related suggestions incorporating social elements were well received; however, efficiency-related suggestions were met with more caution. P10 explained: "*When it is about aesthetics, it makes me feel more comfortable because it does not look like it is based on my data*". Still, most participants are available to share their data, although in an anonymous and untraceable fashion (e.g., for average calculations).

5.2.5   Summary

This section described how people with and without personalization experience respond to and envision using interaction data to support UI personalization. Our findings highlight how users identify personalization opportunities, what factors influence their decision-making, and how they expect to implement and benefit from a data-driven personalization setup. Table 5.3 summarizes the key findings.

5.3   Discussion

In this chapter, we studied opportunities to further empower users in personalization, not merely by offering options to change their UIs but also by enabling informed decision-making. Through an interview study, we examined how putting interaction data at users'

Table 5.3: Results overview.

Identifying Personalization Opportunities

- People can independently identify personalization opportunities using exclusively the data-only dashboards.
- Textual personalization suggestions can help translate data into personalization decisions.
- People desire and favor visual personalization suggestions, which they expect will reduce the effort of analyzing data and personalizing.
- They perceive social suggestions as less individualized but acknowledge that social components can still help enhance aesthetics or identify social trends.
- Personalization suggestions can trigger further personalization intentions, including in alternative contexts and UIs.
- People can struggle to identify opportunities due to their unawareness of UIs and UI personalization.

Decision-Making Factors

- People value access to interaction data and time savings estimates for deciding whether to personalize.
- Interaction data can support reflection on how personalizing can disrupt routines and the effort needed to adapt to personalized UIs.
- Visualizing interaction data can motivate data collection, personalization, and support people reflecting on suggestions they find dubious.
- People favor a moderate personalization process that provides ample time to understand and reflect on the data and suggestions.

Implementing UI Personalization

- People emphasized the importance of controlling the data collection and sharing, as well as the personalization decisions and the definitive personalized UI.
- They expect personalized UIs to feel individualized and to be visually appealing or seamlessly integrated into the original.
- Visualizing interaction data should be optional, although people often analyze visual data representations to identify personalization opportunities and usage metrics to assess opportunities value.

Motivations, Challenges, and Benefits of Interaction Data Monitoring

- People also recognize value in using interaction data to guide behavior change.
- They expect visualizing interaction data to bring existing third-party data collection into the foreground.
- People worry about the effort to analyze data.

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disposal can help them recognize and act on personalization opportunities, ultimately encouraging broader personalization adoption by enhancing its perceived value. In doing so, we explored different stages of the personalization lifecycle (Wood et al., 2023), including *motivation* (e.g., context and users' beliefs), *estimation* (e.g., reflecting on cost-benefit), and *consideration* (e.g., examining cognitive load of changing personal habits).

In this section, we discuss our main findings, organizing the discussion according to our research questions.

5.3.1 Engaging with Interaction Data to Identify Personalization Opportunities (RQ1)

Within the personalization context, **people can identify personalization opportunities independently and by solely relying on data-only visualizations**. Focusing mainly on clicks and scroll heatmaps, people expect benefits from reordering UI elements and sections, hiding unused elements, or creating shortcuts for frequent operations. They favor visual data representations for identifying personalization opportunities and quantitative data (e.g., usage metrics) for assessing personalization benefits.

Still, many opportunities may go unnoticed or are reconsidered when presented as suggestions. **People expect system support in analyzing their interaction habits**, with the results clearly communicated to highlight the significance of implementing specific personalization opportunities. They desire personalization suggestions to translate data into actions. Both textual and visual suggestions can increase awareness of UI elements, usage patterns, and potential personalization options. Social suggestions can also raise awareness of overlooked UI elements and design trends, although they may diminish the sense of uniqueness.

Suggestions accompanied by cost-benefit estimates can also reduce the need for consulting data visualizations, as **people often prefer to bypass data analysis and focus on benefits**. Due to the implementation effort, the impact of textual suggestions depends heavily on users recognizing their benefits, with users being more willing to experiment with personalized UIs when presented with visual suggestions.

Before we debriefed participants about personalization, interaction data resulted in intentions to change behavior rather than UIs. This initial focus suggests both a limited awareness of personalization possibilities and a lack of perceived agency over UIs. However, participants' understanding of how data can inform personalization decisions evolved as the study progressed. This awareness evolution impacted their perceived sense of agency, and they gradually became more confident in identifying and proposing UI changes. Ultimately, they became more demanding, placing higher value on personalized experiences and showing lower preference for less tailored approaches, such as the socially-informed personalization templates.

We also found that personalization suggestions can enhance users' proactivity (i.e., their willingness to personalize before encountering suggestions), indicating that **a rationalized legibility of changes can play an educational function**. Future research should delve deeper into using suggestions to advise or guide users, fostering their awareness of key concepts and empowering them to proactively take control of their UIs. For example, it is important to help users distinguish between correct use (i.e., using interfaces as

intended) and optimal use (i.e., using them in the most efficient or personalized way).

These findings were obtained from participants with different characteristics. The main distinction between experts and non-experts was in how they interpreted the data, with non-experts often questioning the meaning of data points (e.g., scroll heatmaps) and struggling more with reflecting on the impact of cost-benefit metrics. Particularly, to better support reflection on the benefits, these metrics could be improved by incorporating frequency of use into the benefits calculation and highlighting long-term benefits (such as monthly time savings), which can be more impactful and easier to grasp than session time savings. UI personalization expertise did not affect participants' reactions but enabled experienced users to provide confident insights into how interaction data could have improved their past efforts, where they faced challenges identifying and implementing personalization opportunities.

Overall, access to interaction data showed promise to enhance existing personalization approaches, underscoring the importance of further exploring the concept through an in-the-wild study.

5.3.2 Perceptions of Interaction Data Collection and Analysis (RQ2)

We found that UI personalization can strongly motivate data collection. People recognize the value of having their interaction data utilized, especially when it is clearly connected to suggestions that rationalize changes. They expect UI personalization to enhance their **digital comfort**, which includes efficient and contextually adapted UIs that offer a pleasant experience with a minimally disruptive aesthetic.

Conversely, while we anticipated privacy concerns to hinder data collection, we found that **accessing interaction data can positively affect privacy and data agency perceptions**, providing an additional motivation for collecting such data.

We identified three interconnected motives that can help mitigate privacy concerns: negotiability, transparency, and perceived utility. Our findings suggest that accounting for these elements in the design of personalization systems may enhance users' trust in both user- and system-driven solutions. Regarding negotiability, the vignettes illustrated approaches in which people control their data, including decisions about what to collect and when. This concept was well received, as it contrasts with existing feelings of lack of agency over the usage of personal data (Auxier et al., 2019).

Second, our findings suggest that **rationalize changes**, in which personalization suggestions are linked with collected data, **can enhance transparency and awareness of data usage**. While prior research (Sundar and Marathe, 2010) suggests that greater awareness of data collection and privacy practices can increase distrust in system-driven personalization, our results indicate that this awareness can be fostered in ways that preserve user trust. To support this, raising awareness must go beyond enabling data visualizations. It should also involve clarifying how the data is being used, for instance, helping users un-

derstand how their data informs specific suggestions. Simultaneously, this sense-making process can also reinforce users' sense of control over their data and the personalization experience.

Finally, there is a notable relationship between the benefits data provides and people's willingness to disclose it, often referred to as the personalization privacy paradox (Xu et al., 2011; Chellappa and Sin, 2005). In this sense, our findings highlight the importance of **emphasizing the value and advantages of data collection**. An effective way to achieve this can be through personalization suggestions supported by relevant information, including justifications, data, and benefit estimates. Furthermore, a perceived increase in benefits from these suggestions can also serve as a trust-building mechanism, crucial for fostering user trust in the software (Chellappa and Sin, 2005).

We also found two additional motivations for data collection that can be particularly relevant as they intersect with personalization. First, people perceive interaction data as something that can be shared in a controlled manner to enhance their social networks. This sharing could complement and improve the dynamics of existing social approaches to UI personalization, including community-based personalization (Chapter 4). Second, people's interest in increasing their awareness of third-party data collection indicates that a system like *UIPulse* could complement existing system-driven personalization by adding a layer of transparency. Particularly, *UIPulse* could help clarify what data is being collected and offer insights into how that data informs the personalization decisions of those systems.

5.3.3 Integrating Interaction Data Into Personalization Solutions (RQ3)

We found that while people can independently identify personalization opportunities, they still seek software support for identifying and implementing those opportunities. Next, we highlight key considerations for integrating visual suggestions into people's routines, offering insights for both user- and system-driven personalization approaches.

5.3.3.1 Guidance, Rationale, and Transparency

As discussed in the previous chapter, personalization guidance can be crucial to alleviate the mental effort of pondering personalization details. This chapter's results indicate that beyond guidance, **people need a starting point for personalization**, which visual suggestions can provide. Nevertheless, suggestions should not be the endpoint. Instead, they can serve as a foundation or trigger for additional UI changes, allowing users to refine or expand upon the initial suggestions if desired.

Regarding suggestion design, our results highlight the importance of including their rationale and allowing users to explore the underlying data optionally. Previous efforts

to provide rationale ([Bunt et al., 2007a, 2009](); [Anik and Bunt, 2021]()) have focused on explaining algorithms or data usage, but participants either ignored or criticized these rationales for lacking personalized or graphical information. Our findings indicate that **people value rationales that connect system suggestions with their personal data**. They also suggest that if this connection is made, people can better reflect, make informed decisions, understand the benefits, grasp why specific data is collected, and become more aware of how to personalize. This increased personalization awareness can, in turn, strengthen their sense of agency over UIs, encourage a more critical perspective on new interfaces, help them identify similar opportunities in other contexts, and ultimately foster greater independence from system decisions in personalization.

To this end, our results also underscore the importance of personalization software in considering the magnitude of changes. Particularly, **cost-benefit metrics should account for how transformative changes are and their resulting design disruption**. People value cost-benefit metrics for planning the personalization and supporting their decision-making. However, they could be improved by also highlighting long-term benefits and capturing the disruption caused by changes, such as the time it takes users to become more efficient with the personalized UI compared to the original.

Furthermore, our findings suggest that allowing users to review the data underlying personalization suggestions at their convenience can enhance their sense of control, potentially enhancing long-term engagement with the software. This complements prior research, which indicates that explanations are not always necessary, either because the effort to access them may outweigh their benefits ([Bunt et al., 2012]()), or because users typically seek them only in response to specific triggers such as anomalous results or confusion ([Gregor and Benbasat, 1999]()).

Finally, future research should explore how exposure to suggestions rationale and interaction data can affect users' mental personalization model. For instance, people can inspire their personalization in community-based personalization requests, and a similar effect may occur with personalization rationales and suggestions.

5.3.3.2 Introduction Strategies for Suggestions

Our findings highlight the importance of introducing personalization gradually. Changes should be introduced moderately, both in terms of their level of disruption and their frequency. **A gradual approach can be vital for preventing abrupt routine changes** (including lowering the learning curve of the personalized UI) and **building user trust** by starting with suggestions that are understandable, predictable, and clearly beneficial, such as adapting menus while maintaining spatial stability ([Findlater and Gajos, 2009]()).

Designing for moderation also requires attention to the obtrusiveness and timing of suggestions. Prior work on system-driven personalization presents differing perspectives on whether users should be required to interact with adaptations or be allowed to ignore

them (Findlater and Gajos, 2009; Jameson, 2007). We argue that allowing users to engage with and decide on adaptations can be beneficial. It may strengthen their sense of control and help foster user trust in the software by clearly demonstrating the benefits of each change, an approach consistent with the principles of the slow computing philosophy, which emphasize reflection, pacing, and user agency in digital interactions (Kitchin and Fraser, 2020).

To address how the personalization process unfolds over time, future research should also investigate how many adaptations are introduced, how long personalization continues, and when users should be prompted.

First, the personalization process does not need to be limited to one adaptation at a time. Future research should explore the ideal **magnitude of change**, particularly how many simultaneous UI changes can be made without overwhelming users or disrupting their mental models. Although individual adaptations can be helpful, implementing multiple individual adaptations in a short time frame risks confusing users and reducing their effectiveness.

Second, research should study if and when the personalization process concludes, particularly whether it is a continuous process that adapts to UI updates and evolving user behaviors, or a process limited in time that ends once users achieve satisfactory optimization.

Finally, it is also important to examine the optimal timing for interrupting users with personalization suggestions. In mixed-initiative systems (Bunt et al., 2007b), users typically trigger suggestions manually, which may lead to missed opportunities. Kamar et al. (2009) suggests people are more receptive to interruptions when they perceive a clear benefit. This highlights the importance of calculating and clearly presenting context-aware benefits to support and justify the timing of such interruptions.

5.3.4 Design Considerations for Future User Interface Personalization

We envision a digital landscape where individuals have greater control over the UIs they use and the personalization process. This study represents an initial exploration to inform the design of systems that support users' personalization decisions through meaningful interaction data. Table 5.4 outlines our main design considerations to inform future work in this topic.

To translate these ideas into practice, we envision a tool with system-initiated design considerations where users can lead the personalization process through data visualization and user-driven personalization features. This system would offer visual suggestions, along with trade-offs highlighting long-term effort and time savings, optional data analysis, and further personalization options. Suggestions would be connected to interaction data, enabling users to make choices independently and proactively by gaining insight

Table 5.4: Design considerations (DCs) for future user interface personalization with interaction data.

Design Consideration (DC)	Description
(DC1) Support Decision-Making and Personalization	Preserve user-driven personalization and control by providing system-initiated support through visual suggestions, while enabling optional customization and interaction data analysis.
(DC2) Use Multiple Representations	Offer both numerical (e.g., usage statistics, time-saving metrics) and visual representations (e.g., heatmaps) to support users in different decision-making processes, such as identifying personalization opportunities and evaluating their potential value.
(DC3) Provide Meaningful Benefit Metrics	Incorporate cost-benefit metrics that highlight usage context (e.g., time saved in work-related tasks); and emphasize long-term benefits and frequency of use in benefit assessments.
(DC4) Rationalize the Legibility of Changes	Clear the reasoning behind personalization suggestions by linking them to users' data. This can help users clarify unexpected or ambiguous suggestions, and foster trust in the personalization process.
(DC5) Personalize Moderately	Introduce personalization suggestions progressively to prevent abrupt changes to users' routines or UI disruptions. Take advantage of this gradual approach to build trust by starting with suggestions that users are more likely to understand, find relevant, and accept.
(DC6) Communicate Data Usage Clearly	Ensure people understand the value of data collection by providing interaction data visualizations and showing its role in the personalization process (e.g., by linking data with suggestions). This can help users understand the value of sharing their data and increase their sense of control, trust, and security.
(DC7) Foster Proactivity	Encourage user proactivity by providing informative and educational personalization suggestions that can be a starting point or trigger for independent and proactive personalization. For instance, support users in analyzing their interaction data and learning from suggestions (e.g., linking suggestions with interaction data) so they can personalize beyond the system's recommendations and extrapolate suggestions to other contexts.
(DC8) Support Long-Term Engagement	Foster sustained user engagement by clearly communicating the benefits of personalization (DC2, DC3), how interaction data is used (DC4, DC6), and how people can use it (DC7). Ensure users retain control over personalization (DC1, DC6) and streamline its implementation (DC1, DC5).

into suggestions rationale. UI elements would be personalized gradually, ensuring users' adaptation without disruption. The system would also give users control over the data collection context and communicate the long-term benefits, building trust and enhancing security perceptions.

5.3.5 Limitations

Using synthetic data and fictional personas to construct the design probes helped protect participants' privacy and ensured they felt comfortable participating in the study. However, this approach may have limited deeper discussions about personalization opportunities, participants' digital routines, or real-world privacy concerns. While participants did situate their own use cases within the study context, future work could build on these findings to conduct an in-the-wild study to capture more authentic user experiences.

Participants who participated in previous studies on UI personalization can perceive UI personalization differently from the average population. Nevertheless, these participants remained initially unaware that the study was about personalization, as their comments proved. On the other hand, we collected feedback from personalization users, who had a deeper understanding of personalization and the role of interaction data.

5.4 Summary

In this chapter, we investigated the benefits and challenges of a reflexive personalization approach where people are supported to reflect on their digital interaction data to identify personalization opportunities and personalize. In an interview study, 12 participants engaged with design probes in the form of vignettes to reflect on various approaches to integrating interaction data into user-driven personalization, and to consider the extent of system support required to analyze, interpret, and act upon that data.

Our results show that, regardless of UI design expertise, people can autonomously identify personalization opportunities by using interaction data. Nevertheless, they favor system-initiated design decisions with visual suggestions that they can use as a starting point for their personalization. Access to interaction data can also enhance transparency, help users assess the benefits and drawbacks of personalization, and raise awareness of UI design and personalization features, which can be important for supporting an independent and proactive personalization process.

We expect the work presented in this chapter to inspire future research on providing users with access to their own interaction data to support UI personalization. Such research should prioritize transparent and informative data-driven suggestions that are introduced moderately and designed to foster user proactivity, while ensuring users can access the underlying data to clarify and review these suggestions.

Chapter 6

Discussion and Design Space

This dissertation explored how people experience and envision UI personalization, including their preferences, challenges, and the types of support they require to exercise more democratic control over the interfaces they use. In this chapter, we answer each research question in a dedicated section. Then, building on the insights developed throughout this dissertation, we propose a design space that consolidates much of the knowledge generated in this work.

This chapter contributes **a design space of end-user user interface personalization (C6)**.

6.1 Research Questions

In this section, we address our proposed research questions.

6.1.1 Exercising Democratic Control Over User Interfaces and the Role of Personalization

RQ1: *How do people envision exercising democratic control over the interfaces they interact with, and how do they see personalization mechanisms supporting this process?*

To understand how people envision exercising control over the interfaces they use, it is first important to examine how they currently perceive these interfaces. These perceptions, observed across all our user studies and most clearly evident in Chapter 3, were consistent across diverse populations, including experts and non-experts, users with varying levels of technical expertise, and people with different abilities.

We found that most non-experts view **interfaces as immutable entities**, designed by experts with good intentions, and beyond the scope of what they can change (Section 3.1.2.2, Section 4.2.1.2, Section 5.2.1.4). In practice, people tend to **adapt themselves** to user interfaces rather than the other way around. They do this in two main

ways. First, they avoid interfaces that are not usable, visually appealing, or comfortable to use. This is only possible when viable alternatives exist or when the problematic interface belongs to a system they do not need to use. Second, when avoidance is not an option, because a service is essential or the issues are minor within the UI context, people develop workarounds. Over time, they adapt to these workarounds, ignore some of the problems, and become accustomed to the limitations, often failing to take advantage of personalization even when available (Section 3.1).

This behavior reinforces a mindset in which people rarely consider personalization. In Section 3.1.2.2, we saw that they often have **limited awareness** of what personalization is or what it can enable. In Section 3.2.2.1, we found that while most people occasionally encounter situations where they would like to change aspects of their UIs, they tend to accept them as they are and rarely take action.

Across our studies, however, there were **moments of mindset shift**. Participants realized that UIs can be changed and personalized to individual needs, and that UI creators have not always enabled such meaningful changes. In our first study (Chapter 3), this shift emerged during the personalization session (Section 3.1.2.3). In the study on personalization assistance (Chapter 4), the turning point came when participants received customization requests from others, highlighting how UIs could be adapted (Section 4.2.3). Finally, in the study on interaction data (Chapter 5), the shift was prompted by visual personalization suggestions, which encouraged participants to consider alternative designs (Section 5.2.1.4).

People believe it is important to be **made aware** of and "*educated*" about all the tools they are "*entitled*" to use for personalization (Section 3.1.2.3). Once they realize UIs can be adapted and reimagined, they express a strong interest in exercising control and personalizing their interfaces. They just need time to adapt themselves to access such tools and take action when they identify a personalization opportunity. We received encouraging feedback regarding how people would like to engage with personalization, as seen in Section 5.2.1.4: "*Just as social media profiles reflect ourselves, why should not the websites we frequent also reflect a bit of who we are?*".

This process of getting used to personalization highlights how personalization benefits from **guidance** and a **moderated** or **slow computing approach** (Section 4.2.1.2, Section 5.2.2.3). People need support to explore and experiment with personalization options at their own pace, developing confidence as they learn how interfaces are structured, how to use certain operations for their benefit (e.g., when and where to add shortcuts), and how changes might affect their routines. Adopting a slow computing perspective (Kitchin and Fraser, 2020) means allowing personalization to unfold gradually and reflectively, with a **magnitude of change aligned with users' pacing**, enabling them to progressively become more aware of their own behaviors and identify where personalization can make a difference.

Realistically, people are willing to personalize only in certain situations. Prior work has shown that users are reluctant to invest the time and effort needed for personalization unless they perceive long-term value (Mackay, 1991; Banovic et al., 2012). Our findings build on this, showing that each individual assesses the value of personalization differently (Chapter 3). For example, some prioritize personalization in work-related contexts, often to improve efficiency. Others value it more in recreational environments, often to improve aesthetic comfort or express their identity. One point is clear: people are interested in personalizing, but only the UIs they use regularly, and even then, in a process that will only occur occasionally.

In Chapter 3, we explored, both in depth and at scale, the motivations, challenges, and barriers to adopting personalization. We saw how important it is for people to **control** and **trust** personalization mechanisms, and not feel their **privacy** compromised. People particularly see privacy and controllability as barriers to installing system-driven personalization software. Control, in this sense, extends to different components of the personalization process, including deciding what is personalized, when features are enabled or disabled, and the ability to revert changes. In Chapter 5, we found that engaging with interaction data can enhance users' sense of empowerment, control, and privacy by enabling them to make informed decisions and visualize collected data. Simultaneously, this also highlighted additional control-related needs, such as controlling the data itself, and reinforced the importance of transparency and predictability in situations where systems propose UI changes.

We also identified other factors influencing personalization adoption (Chapter 3), including challenges with varied impact across the typical personalization approaches. For example, lack of time, high complexity, and limited programming skills can particularly affect user-driven and mixed-initiative approaches. These factors, combined with the diversity and complexity of personalization needs, which we will discuss in the next section, underscore the importance of exploring solutions that facilitate personalization implementation. Examples include community-based personalization and system-initiated design suggestions.

Furthermore, satisfaction with existing interfaces is itself a relevant reason for not engaging in personalization. That said, **personalization is not something people expect to do on a daily basis, but when they do, they want access to controlling every detail they need**. As circumstances change, satisfaction with interfaces can shift quickly to dissatisfaction, such as when a UI is updated, prompting a desire to personalize to revert to older designs. Such updates illustrate how some of the challenges associated with personalization are already present in current digital environments, even without explicit personalization features. For example, when UI creators introduce layout changes, they can unintentionally cause routine disruption (Section 5.2.2). This is a challenge we believe can be mitigated through the moderated introduction of changes (Section 5.2.2.3).

On the positive side, people are curious about personalization and expect to use it for various purposes, above all to improve **efficiency** and **visual comfort**. Furthermore, this curiosity can turn into excitement when discussing futuristic personalization mechanisms, such as visual suggestions (Section 5.2.1.2).

6.1.2 Use of Existing Personalization Features and Users' Needs and Preferences

> RQ2: *What use do people make of existing user interface personalization features, and what are their personalization needs and preferences?*

People actively personalize their interfaces, most often by using built-in personalization options (Section 3.2.2.1). We found that changes to icons, wallpapers, font size and type, or colors are particularly common.

Although many users (41%) have demonstrated interest in installing third-party personalization software, only a small proportion (around 10%) actually have such tools installed. People use third-party solutions mainly for aesthetic adjustments, such as modifying icons, widgets, keyboards, and wallpapers. However, there is a general lack of awareness about the existence of personalization tools or where to find them. Privacy concerns are also a common reason for not searching for or installing personalization software.

As discussed earlier (Section 6.1.1), the absence of extensive personalization does not necessarily indicate a lack of interest. Instead, **people are unaccustomed to thinking about personalization** in the first place (Section 3.1.2.3), often unsure about what can be changed or what changes would be beneficial (Section 4.2.1.2).

Interestingly, the changes people make, and those they would like to make, rarely involve a complete reshaping or reimagining of the interfaces they use, even though they value having that possibility. Instead, personalization is often about feeling comfortable and creating what participants described as "cozy spaces" (Section 5.2.2.1), which can frequently be achieved with few adjustments, such as color changes (Section 4.2.1).

We found many personalization options that can still be added to enable the creation of those cozy and comfortable spaces, beginning with homepages and menus (Section 3.1.2.1). People desire options that allow the creation of more **efficient** and **simpler UIs**. This includes reorganizing, hiding, or moving elements, and adding shortcuts. Features related to visual comfort and aesthetics could also be enhanced. This includes the ability to resize and recolor elements, with color changes going beyond the predefined modes currently available. People want to recolor specific interface elements using precise colors that hold personal significance.

People's **personalization needs are often complex and highly individual** (Section 3.1.2.1). First, UIs are dynamic, and many people want changes to apply only in

specific contexts or particular types of content. This requires a personalization logic that considers not only the structure of a layout but also its content. Second, some personalization ideas are deeply personal and shaped by individual background or education (Section 3.1.2.2). For example, users might desire to redesign a digital newspaper interface to replicate the style of a specific physical newspaper they value.

Unless personalized UIs are completely dedicated and tailored, there will almost always be small details that people wish to change in order to achieve a truly comfortable and enjoyable interface. For example, even with system-driven adaptation, or when a wide range of templates is available and some align closely with individual preferences, further adjustments may still be needed to meet specific expectations (Section 5.2.1.2).

Overall, these personalization preferences highlight the need for solutions that provide meaningful user control, address the diversity and uniqueness of personalization needs, and account for varying levels of expertise and availability to implement changes.

6.1.3   Supporting Users in Taking Greater Control Over the Personalization Process

RQ3: *How can we support users in taking greater control over the personalization process, in accessible ways that advance UI democratization by promoting personalization freedom, human independence, and informed decision-making?*

A key part of ensuring that UIs can be adapted to individual preferences is enabling users to take active control over the personalization process. This goes beyond controlling a specific personalization tool and involves using personalization to define every aspect of an interface. Ultimately, we found that **enabling control also requires designing personalization software that supports unforeseen and unique changes**, creating an unrestricted personalization environment that should be made accessible to those who lack expertise, availability, or advanced design skills (Section 3.3).

People prefer a user-driven personalization approach for exerting such control. Their negative experiences with other types of personalization, such as content adaptation that occurs automatically and often in undesired ways, have reinforced the importance of user control (Section 3.1.2.3). Furthermore, these experiences are frequently accompanied by malleability (e.g., the ability to revert changes) and privacy concerns.

While user-driven personalization requires individuals to make decisions and invest time in considering changes and solutions, this process does not have to be isolated, nor do people wish it to be (Section 5.2.1.2). We found that people value an **assisted user-driven personalization process**, in which they retain full independence in modifying any UI detail while receiving support in identifying personalization opportunities, implementing changes, and ideating alternative designs. We identified four key areas to support users'

personalization process.

Allow for the Unexpected.   As discussed in Section 6.1.2, personalization needs and preferences can be highly unique, complex, and dependent on personal context or background. Traditional user-driven, system-driven, and hybrid personalization approaches often cannot accommodate this diversity, and the same limitations apply to design strategies following principles of inclusive design or design for all (Chapter 2). The challenge of supporting this diversity became evident when developing the customization tool used in the first study (Chapter 3). Initially, it included common personalization options, such as moving elements and changing colors. Over time, unexpected personalization requests led to the addition of further options, such as adjusting line spacing and the inclusion of additional configuration parameters, such as recoloring only a single container or its nested elements. Ultimately, this resulted in a tool that would overwhelm a regular user. We believe the best way to ensure that truly unexpected changes can be made is to support **unrestricted** *CSS* or *JavaScript* modifications.

Facilitate Reflection and Rationalization.   Many users do not actively recognize interaction problems or reflect on how their UIs could be different. Interfaces are often used in a routine, almost automatically (in "*zombie mode*"), without pausing to consider possible personalization changes. In Section 3.1, we asked people to reflect on a daily basis on desired changes. We found that creating reflection moments for thinking about how UIs could be improved is important. However, these moments can be most effective when supported by relevant data or suggestions, allowing reflection to occur concerning concrete examples.

Support Solutions Ideation.   Once people get used to an interface, envisioning it in a different form can be difficult. While some changes can be intuitive, such as reorganizing menus or adding shortcuts, others require significant reflection and design consideration. One such case is when users want to move from a UI that feels uncomfortable to something they perceive as comfortable, which can be a matter of feeling through exploring and testing visual cues (Section 3.1.2.2). In other cases, people can have difficulties in conceptualizing UIs, especially in understanding what UI aspects of UI can be adapted (Section 4.2.1).

We found some strategies that people expect to assist with the ideation process. These include fully user-driven approaches, like supporting users in experimenting with different styles and properties or replicating UIs they enjoy (Section 3.3.2), or system-initiated approaches, such as presenting multiple alternative layouts, templates, or visual suggestions that inspire further personalization (Sections 4.2.1.2, 4.2.3.4 and 5.2.1.2).

Facilitate Execution. Execution concerns the process of turning ideas into tangible interface modifications. For certain changes, this transition can be straightforward, requiring only a few steps using a predefined set of personalization options (e.g., pick a color). Furthermore, some ideation-support mechanisms, such as visual suggestions, inherently aid execution (Section 5.2.1.2).

In other cases, execution can be more complex and time-consuming than ideation, sometimes requiring programming skills. For example, adding a new column to a table with data sourced externally may exceed the skills of many users or may not justify the effort involved (Section 3.1.2.1).

Facilitating execution does not mean that personalization should be fully automated. While users appreciate system support, it is crucial that they retain the ability to make and refine changes themselves (Section 5.2.1.2). Some users even value the process of crafting changes or writing code (Section 4.2.1.1); for them, facilitation may involve features such as integrated code editors with syntax checking. Experts, in particular, value the customization process and the sense of control it provides (Sundar and Marathe, 2010).

The act of implementing changes can foster self-reflection, increase awareness of UI structures and personalization opportunities, and inspire reflection on how similar modifications might apply across other interfaces (Sections 3.1.2.2 and 4.2.3.4). Therefore, it is essential to foster confidence in personalizing interfaces (Section 4.2.1.2). Users should be encouraged to explore available options without fear of breaking an interface or making irreversible changes (Section 3.2.2.4). They should be supported to "play" with personalization as a dual process of both learning how to use the software and reflecting on other contexts where they might apply similar personalization operations (Sections 3.1.2.3 and 5.2.1.4).

Beyond this, future research should explore ways of making writing bespoke *CSS* and *JavaScript* code more accessible to non-experts, thereby lowering the effort barrier for the wider population. Promising directions include enabling personalization through natural language, leveraging community-based solutions, and supporting implementation through conversational agents and low-code or no-code platforms (Chandra Gundlapalli, 2021; Muhammad et al., 2024).

6.1.3.1 Community-Based Personalization to Reduce Effort and Expertise

We proposed and studied an approach designed to support personalization implementation by reducing the effort and expertise required from individuals (Chapter 4). In this approach, users can request assistance with personalization tasks and contribute by supporting others in their customization efforts. The findings suggest this concept is feasible, as people are open to collaboration under different circumstances. **People are open to and enjoy customizing for others, motivated by the positive feelings of being helpful and by the challenge that the task represents** (Section 4.2.3). Most people anticipate

receiving new requests and dedicate specific moments in their daily routines to addressing them.

This form of collaboration also aligns with our broader goal of increasing users' agency over interfaces. Addressing others' requests not only provides opportunities to practice personalization, thereby building confidence in using available options, but also serves as a trigger for reflecting on one's interactions and personalization opportunities (Section 4.2.3).

The commitment to volunteer work is evident across individuals with diverse levels of expertise and backgrounds, as well as across requests of varying complexity and origin. These are promising indicators of how users may engage in community-based personalization assistance. However, long-term behavior should be further studied (Section 4.2.3.2). For sustained engagement, our findings show that users value mechanisms such as **gamification that reinforce motivational factors** (e.g., challenge and emotional reward), **feedback and communication channels**, and the ability to **self-select** which requests to address.

On the other side of these dynamics, we found people avoid creating personalization requests (Section 4.2.2). The number of personalization attempts in our study was limited to the minimum required, and when people decided to personalize, they preferred to implement changes independently. While some are open to submitting requests for complex personalization tasks beyond their ability, others believe that if they can not solve a problem, other community members will also be unable to do so.

Although users generally prefer to personalize on their own, future work should investigate their behavior in contexts where more personalization opportunities become available, either through mechanisms that support opportunity identification or in long-term settings where opportunities that benefit from community efforts can eventually emerge. Future explorations should also consider the role of users' confidence in the perceived value of their personalization ideas. Our findings indicate that individuals may be uncertain about the usefulness of the opportunities they identify. When still becoming familiar with personalization tools or the types of changes that could benefit them, users may feel less comfortable requesting assistance, either because of difficulties articulating the request or concerns about burdening others with changes they are unsure are worthwhile.

In summary, seeking community-based assistance is unlikely to appeal to everyone. However, for situations when people choose to seek community support in their personalization efforts, there is evidence that community members are willing to help.

6.1.3.2   Engaging With Personal Interaction Data for Informed and Independent Decisions

Access to personal interaction data can support decision-making across different stages of personalization, particularly in identifying interaction issues and reflecting on the costs

and benefits of potential changes (Chapter 5).

People can independently and intuitively identify personalization opportunities by exclusively analyzing raw interaction data through visualization dashboards (Section 5.2.1.1). Accessing this data can add value to the personalization process, providing a starting point for understanding which UI elements could be rearranged or adapted. This effect is particularly evident among users with prior personalization experience, who are more aware of the challenges involved in identifying opportunities without dedicated support. Moreover, accessing interaction data helps **make routines visible**: users who typically navigate in "*zombie mode*" can pause, analyze their interactions, and reflect on behaviors that may have gone unnoticed (Section 5.2.1.5).

Nevertheless, many opportunities may remain hidden when relying solely on raw data, and the process of analyzing the data and implementing changes can be time-consuming (Section 5.2.1.2). To address this, we explored three approaches for system-supported identification of personalization opportunities and implementation. We found that **people value having their data translated in the form of visual suggestions**, previews of potential changes that users can adopt, accompanied by a **rationale and optional access to underlying data**.

Importantly, this form of system-initiated design suggestions does not diminish users' role in the personalization process (Section 5.2.2.1). The ability to manually customize UIs, analyze the data independently, and selectively accept suggestions, based on informed decisions users make by accessing rationales clearly informed by and linked with their data, can still ensure that users retain control and feel empowered. Users may not always need to review the underlying data for every suggestion, but having the option to validate and understand suggestions when desired reinforces confidence and informed decision-making.

Moreover, a legibility of changes through rationalized suggestions clearly linked to interaction data can provide additional benefits for personalization. They can encourage a mindset shift, increasing awareness of personalization possibilities, motivating users to extrapolate suggestions to other contexts or UIs, and fostering proactive engagement with personalization opportunities (Section 5.2.1.4).

6.2 The Design Space of End-user User Interface Personalization

This section presents a design space that captures the dimensions and qualities people value and expect from UI personalization. We then exemplify how the design space can be used to illustrate and evolve existing systems and ideate novel solutions.

6.2.1 Design Spaces

Design spaces are theoretical frameworks that capture the key dimensions of a design (Card et al., 1991; MacLean et al., 2020; Card et al., 1990; Lee et al., 2024; Nicolau et al., 2019; Guerreiro et al., 2023). They commonly fulfill three roles, which we anticipate our design space will also address. They can provide a shared vocabulary to support communication and collaboration among researchers, designers, and stakeholders. They also serve as a tool for examining and reflecting on existing designs, helping to reflect on why certain design choices were made and to assess why a design may be effective in some contexts but fail in others. In addition, design spaces can inspire new designs by highlighting underexplored regions of the space that can be promising directions for future work.

Design spaces are not intended to be exhaustive or fixed; they provide avenues that enable researchers and designers to explore, understand, and compare diverse potential approaches (Lee et al., 2024; Guerreiro et al., 2023). They are typically structured around a set of categories or dimensions considered central to a domain, with each category associated with possible values that can expand based on new design explorations. This flexible structure allows design spaces to evolve over time, accommodating technological developments and new research insights.

Existing approaches to structuring personalization, whether framed as taxonomies, frameworks, or design spaces, have been primarily developed with a focus on system-driven adaptation (e.g., (Gajos et al., 2006; Carrera-Rivera et al., 2024)), often neglecting the role of end-users in the process and concentrating on how systems execute personalization (e.g., (López-Jaquero et al., 2021; Bouzit et al., 2016)). For example, a line of research has focused on dimensions such as what to adapt, when to adapt, why to adapt, and how to adapt (Karagiannidis et al., 1996; Motti and Vanderdonckt, 2013; Abrahão et al., 2021). Similarly, researchers have also proposed design spaces that represent the lifecycle of adaptations from perception to action (Bouzit et al., 2017b,a) or from critique to evaluation (Myrhaug and Thomassen, 1997), as presented in Figure 2.7.

While these frameworks provide valuable guidance for designing adaptive systems, they often overlook aspects that end users explicitly value, such as privacy, controllability, decision-making support, or the ability to redesign personalized interfaces. In this section, we present a design space centered on end-user considerations, highlighting factors that support meaningful, informed, and independent personalization, without addressing technical deployment aspects considered in other frameworks.

6.2.2 The Design Space

Our design space aims to capture people's experiences and expectations regarding UI personalization. It was developed through an iterative process grounded in our empirical

findings. We began by reviewing and organizing the themes and codes that emerged across our user studies, grouping related concepts and reflecting on their connections. This process revealed relevant concepts that informed the categories and dimensions representing how end-users envision personalization and what they value in it.

The design space was collaboratively refined across multiple meetings involving three researchers. During these sessions, we systematically discussed the codes, themes, and supporting quotes to ensure that the emerging dimensions captured our findings and the broader state of the art in UI personalization. These meetings also focused on aligning the terminology of categories and codes with established nomenclatures in research fields like personalization and human-data interaction. Initial category candidates were outlined before the first meeting, then proposed and discussed one at a time, with subsequent meetings used to iterate, merge, or split categories and values as needed to achieve clarity.

We constructed the design space focusing on what is meaningful and relevant to end-users. Our findings show that users understand personalization through its practical implications, including how much effort it requires, how much control they retain, and how supported they are. For instance, while distinctions such as user-driven or system-driven are common in research, they may not capture how users conceptualize personalization, as users tend to think instead about how much work it involves, how easily they can undo or refine changes, and whether they can trust the system's underlying data practices or manage their data. We therefore framed the dimensions around a user-centered vision, ensuring that the design space represents personalization in terms that align with users' perspectives and values.

We anticipate this design space will be useful for researchers and practitioners developing personalization features, including built-in and third-party solutions. Beyond guiding new designs, the space can support the analysis and reflection of existing personalization mechanisms, foster dialogue and mutual understanding with end-users, and ultimately contribute to the creation of innovative personalization features that align with users' needs and values.

Figure 6.1 presents the design space as a 7-axis radar chart. It covers seven categories: *extent of personalization*, *magnitude of changes*, *legibility of changes*, *data agency*, *malleability*, *execution assistance*, and *decision support*.

We mapped the ordinal values onto the axes such that the most supportive, unrestricted, or transparent values are placed further away from the center of the radar chart. Next, we describe the categories and their corresponding values in detail.

Extent of Personalization. The *extent of personalization* category captures the range and flexibility of personalization that is possible for both users and systems. It represents how extensive and unique personalization can be, describing the extent to which personalization options enable the adaptation of interfaces to individual needs and preferences.
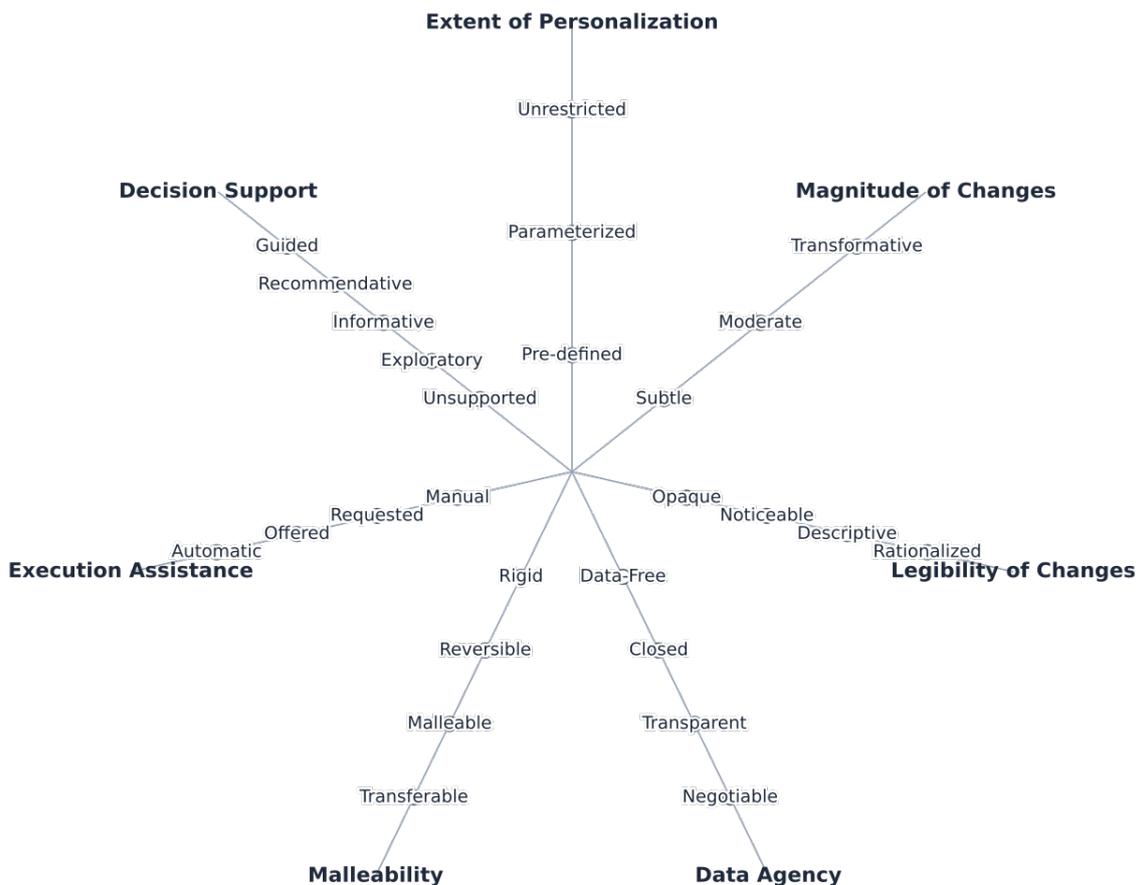
Figure 6.1: The design space of end-user UI personalization.

This includes not only how many properties (e.g., element size, position, color) can be changed, but also how freely their values (e.g., coordinates, dimensions, or color codes) can vary. The spectrum ranges from *pre-defined* personalization, where options and values are fixed and shared across users, to *parameterized* and *unrestricted* personalization, where personalization can produce highly distinct or even entirely reimagined versions of the original UI.

Personalization is *pre-defined* when only fixed options or templates are available (the properties and their possible values are fixed), leaving no room for new or unique configurations (e.g., color themes or layout presets). It becomes *parameterized* when multiple, though not all, properties can be personalized and their values can vary freely within reasonable limits (e.g., resizing or repositioning elements). At the most open level, personalization is *unrestricted*, when any property or operation can be modified without limitation (e.g., through scripting or direct code manipulation), allowing complete transformations of the interface's structure, appearance, or functionality, even at the cost of usability or coherence.

Magnitude of Changes.   The *magnitude of changes* category represents how disruptive or noticeable personalization is to the user. Personalization is *subtle* when changes are minor and affect a single aspect (e.g., colors), so the interface remains largely familiar. When multiple aspects are modified together or a single significant aspect is changed (e.g., when a frequently used button moves), personalization is *moderate*, producing noticeable differences while keeping the interface recognizable. At the most disruptive level, personalization is *transformative*, when many or all aspects change simultaneously or in a short time frame, potentially including structural modifications or new functionality, making the interface feel completely transformed and redesigned. *Subtle* and *moderate* changes also imply that modifications are paced over time. For instance, if small, incremental changes occur too close together, their combined effect can result in a *transformative* experience.

Legibility of Changes.   The *legibility of changes* category describes how clearly users can perceive and understand the reasoning behind personalization changes or suggestions, regardless of whether the user or the system initiates them. The concept of *legibility* draws on principles from human-data interaction research (Mortier et al., 2014), which emphasizes the importance of making data and analytic processes transparent and comprehensible to individuals. In this design space, *legibility* reflects the degree to which personalization decisions can be interpretable and justified, helping users grasp both what is being adapted and why. It ranges from adaptations that occur invisibly to those that are transparently explained and contextualized for users.

Personalization is *opaque* when changes or suggestions occur without any notification, explanation, or supporting rationale. It is *noticeable* when the system indicates that something has changed or could be changed, but without further detail. It becomes *descriptive* when the system provides a basic, generic account of the factors influencing a change (e.g., "*When deciding what to personalize the system balances your usage frequencies, your expertise, or your interface size (...)*" (Bunt et al., 2009)). Finally, it is *rationalized* when a clear, tailored justification is provided, helping users understand why a change or suggestion was made and what its intended effect might be (e.g., "*This is your most used item, but it is hidden in a submenu. We suggest a new position and estimate you will be 20% faster with this change*"). Personalization is also *rationalized* in fully user-driven setups, when users themselves identify and implement the changes.

Data Agency.   This category represents the extent to which users have agency over the data that informs personalization, including how they can access, understand, and manage its collection and use. It builds on broader notions of data transparency and agency (Mortier et al., 2014), focusing not only on visibility but also on whether users can meaningfully engage with the data that drives personalization.

Personalization is *data-free* when personal data is not collected. It is *closed* when data is collected and processed invisibly, giving users no access or understanding of what is being used or why. It becomes *transparent* when users can see or understand what data is collected and how it contributes to personalization. Finally, it is *negotiable* when users can engage with their data, including managing or restricting its use, and interpreting how it shapes personalization outcomes.

Malleability. This category captures the degree of flexibility users have to adjust and extend a personalized interface after its creation, emphasizing how they can manipulate their settings, code, or templates over time. Personalized UIs may function like a snapshot, a captured interface state that can remain fixed or be further modified. Malleability, therefore, ranges from no flexibility, where the personalized interface is static, to full flexibility, where users can continuously refine, remix, and reuse their configurations across contexts.

Personalization is *rigid* when users cannot modify or undo changes, such as responsive or constraint-based layouts that are out of users' control. It is *reversible* when users can restore previous states or revert to the original interface. It becomes *malleable* when users can continuously refine and update their personalizations. Finally, it is *transferable* when users can reuse, clone, or share their personalized interfaces across devices, environments, or with other users.

Execution Assistance. This category represents how users are supported during the execution of personalization, focusing on mechanisms that reduce the cognitive and physical effort required to implement changes. These forms of assistance involve a trade-off between effort and control: as the level of system support increases, users typically exert less effort but may have less direct control. Execution assistance ranges from no assistance (fully user-driven and user-initiated) to hybrid assistance (user-driven but system-initiated) to full automation (system-driven and system-initiated).

Personalization is manual when users perform all modifications independently without help. It is *requested*, when users can actively request specific changes to the system (e.g., interacting with conversational agents) or to other users. It becomes *offered* when the system provides personalization resources, such as templates, previews, or recommendations that users can choose to adopt, whether these are proactively suggested or made available for browsing. Finally, personalization is *automatic* when changes occur with minimal or no user involvement (e.g., context-aware adaptation). These forms of execution assistance can coexist within a single product, allowing users to move along them depending on their needs, skills, or context.

Decision Support. This category captures how users are supported in making personalization decisions, including what and how to personalize. Support here refers not merely to assistance, but to the underlying infrastructure that enables, informs, or guides decision-making.

Personalization is *unsupported* when users make decisions independently, with no structural or informational support. It becomes *exploratory* when users can draw inspiration or experiment with available resources, such as interaction logs, community templates, or other user interfaces (as in example-based approaches (Kumar et al., 2011)). Decision support is *informative* when the system provides general, non-tailored cues or examples that may inspire change without being directed to a specific user (e.g., "*Most people reorganize the menu items*"). More direct and personalized support is *recommendative*, where users receive concrete, tailored suggestions either from the system (e.g., a recommendation algorithm or conversational agent) or from others (e.g., "*Based on your usage, we recommend adding a shortcut for X*"). At the most supportive level, personalization is *guided*, where users are walked through personalization with step-by-step instructions (such as walkthroughs, comparative previews, or contextual explanations) that clarify the rationale and potential consequences of each decision.

While the previous dimension (*Execution Assistance*) captures how personalization is performed, *Decision Support* focuses on how users are guided in determining what changes to make. For example, individuals' decisions about *requested* personalization (e.g., requests made to members of a community) can range from being entirely *unsupported* to highly *guided*, depending on how people were supported to reason about the request. Similarly, *offered* personalization (such as accessing preview templates) can vary from an *exploratory* process, where users browse templates, to a *recommendative* one, where they receive templates as concrete suggestions.

6.2.3 Usage of the Design Space

In this section, we propose three usages for the design space. We first represent four personalization systems in our design space. We then use the design space to ideate on the evolution of these solutions. Finally, we speculate on a novel approach.

6.2.3.1 Representing Existing Solutions

We illustrate four personalization solutions that we have been discussing in this dissertation: *Stylish*, *CrowdAdapt*, *GitUI*, and *Reflow*. We selected these systems to include user- and system-driven approaches to personalization. For each dimension, we illustrate the maximum value that the system can support, based on the end-result personalization that users can achieve with it.
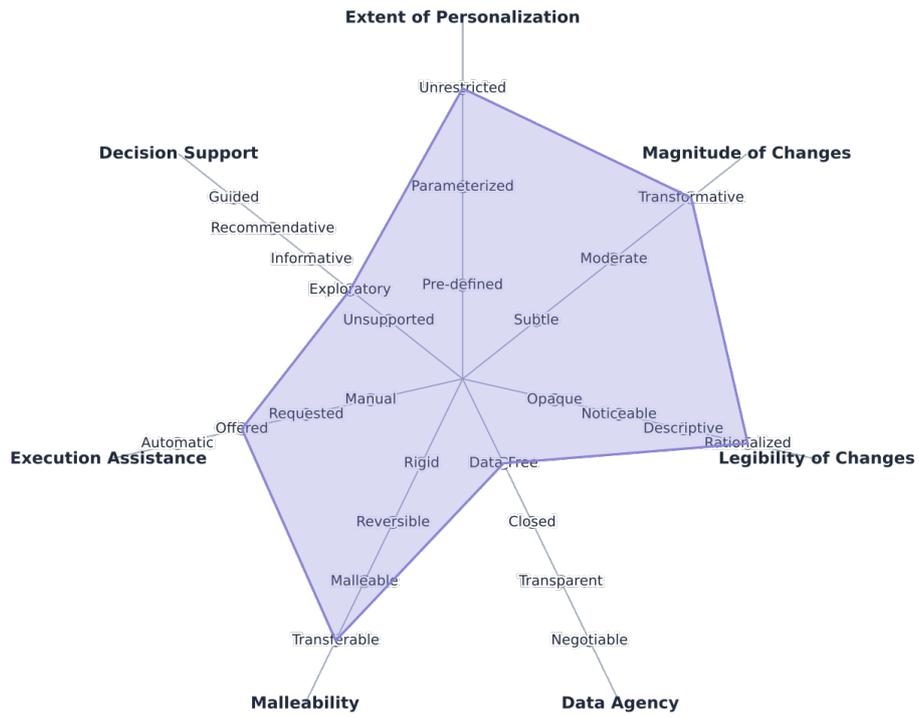
Figure 6.2: Illustration of *Stylish*'s personalization features.
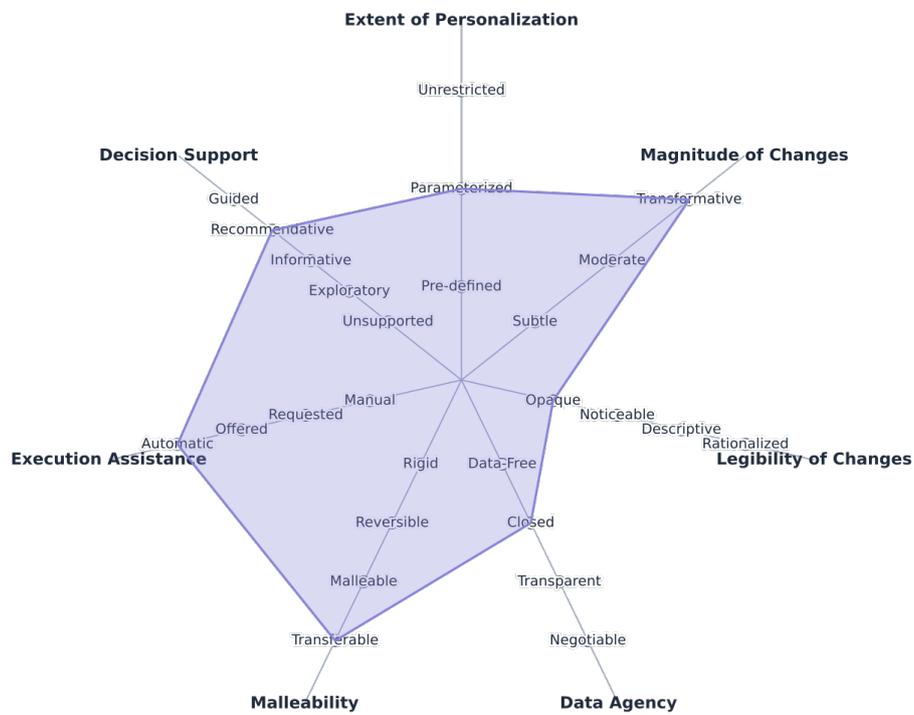
Figure 6.3: Illustration of *CrowdAdapt*'s personalization features.

Stylish. We start by representing what is probably the most popular third-party UI personalization tool, *Stylish* (SimilarWeb, 2022b). The extension allows users to install publicly shared templates or write their own *CSS*. However, these templates function as fully defined interface alternatives rather than adaptable designs that support further tailoring. Figure 6.2 illustrates *Stylish* according to a scenario where users can both install templates and write CSS for their own use. In this configuration, *Stylish*'s personalization features can be characterized as *unrestricted*, since users can create any CSS rules they wish; *transformative*, because they can radically restructure the original interface; and *rationalized*, as users decide for themselves which changes to apply. It is also *data-free*, because no interaction data is collected; *transferable*, because user-created templates can be published and reused; *offered*, because the extension provides access to a gallery of templates; and exploratory, since publicly shared designs can inspire users' decisions.

CrowdAdapt. *CrowdAdapt* (Nebeling et al., 2013, 2012) is a key reference in UI customization research. It enables users to personalize interfaces using predefined operations while supporting automatic adaptations based on crowd-based templates matching users' behavior. Optionally, users can preview the public templates that the system identifies as suitable and choose which ones to apply. However, the system does not provide explanations for its suggestions nor enable control or visualization of the data it collects. Reflecting these characteristics, *CrowdAdapt* can be described as *parameterized*, since personalization is constrained to predefined operations; *transformative*, because available operations allow users to reshape interfaces substantially; *opaque*, given the lack of insight about recommended templates; and *closed*, as users cannot access or modify data that informs personalization. It is also *transferable*, as templates circulate among users; *automatic*, since templates can be applied automatically; and *recommendative*, as it can also recommend suitable templates to users (Figure 6.3).

***GitUI* (version 0.1).** The version of *GitUI* used in Chapter 4 also employs personalization templates, which users can create for themselves and others, and reuse across different devices. It allows users to customize interfaces using predefined operations, unrestrictedly program in *JavaScript* and *CSS*, and redesign templates on top of each other. Accordingly, *GitUI* can be described as *unrestricted*, as predefined operations do not bind users; *transformative*; and *rationalized*. It is *data-free*, because no interaction data is collected; *transferable*, because templates can be shared and reused across devices; *requested*, as users can request personalization changes to others; and *unsupported*, as templates, even those created by others, are bespoke and not intended to guide users in making personalization choices (Figure 6.4).
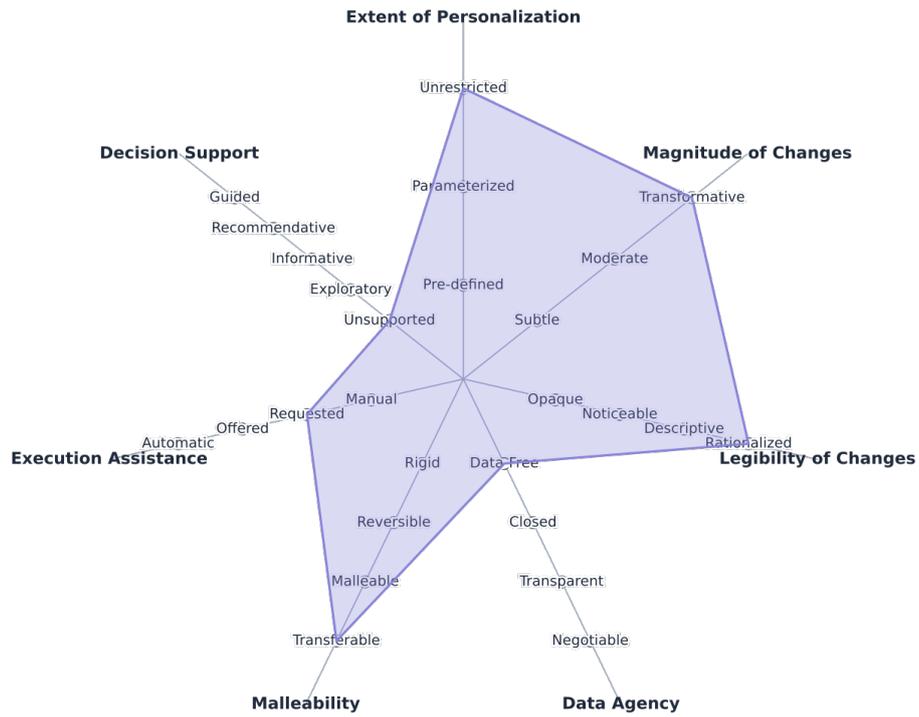
Figure 6.4: Illustration of *GitUI*'s personalization features (version 0.1).
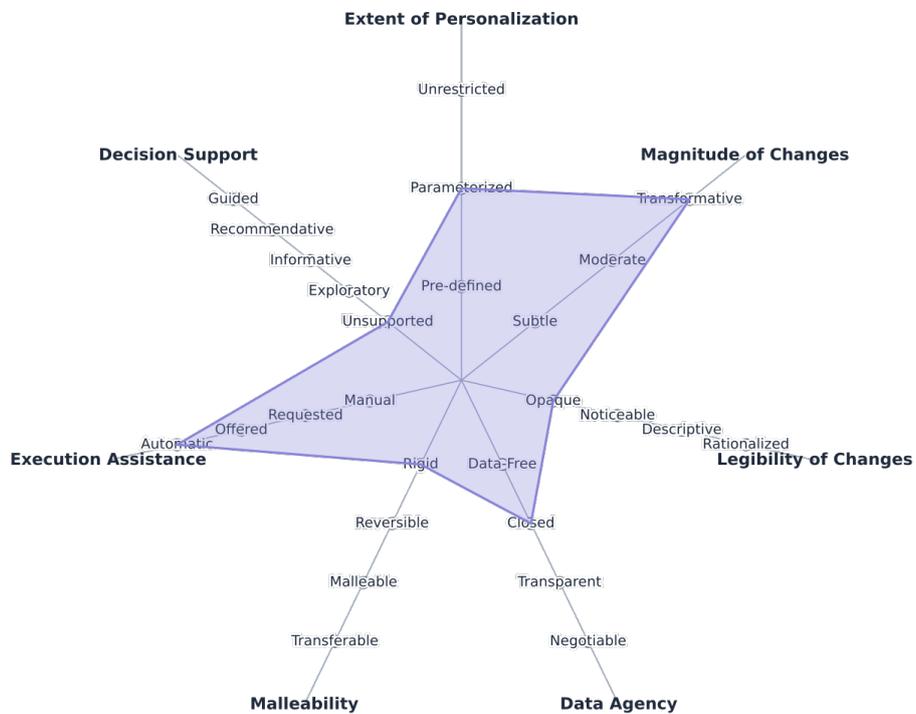
Figure 6.5: Illustration of *Reflows*'s personalization features.

Reflow.   In contrast, *Reflow* (Wu et al., 2022) automatically adapts user interfaces. Users can calibrate the software, after which the system determines optimal element placement while avoiding significant UI disruption. User control is limited to the initial calibration and turning the tool on or off. Although interaction data is collected, users cannot inspect or manage it. Consequently, *Reflow*'s personalization features can be described as *parameterized*, as personalization operations are limited to the implemented rules; *transformative*, since the system does not consider whether to apply or not multiple changes simultaneously; *opaque*; and *closed*. Personalization is also *rigid*, as users can not adjust changes; *automatic*, because changes are system-driven; and *unsupported*, as users receive no guidance or rationale for the resulting adaptations (Figure 6.5).

6.2.3.2   Evolving Existing Solutions

Our design space facilitates reflection on the personalization features of existing solutions, which can serve as inspiration to discuss forms of evolving such solutions. This discussion can be especially effective when these solutions are considered alongside an ideal solution from the users' point of view.

In this section, we first illustrate in the design space how the categories and values correspond to the preferences reported by most participants in our user studies. We then use this illustration to reflect on how some of the solutions discussed could be evolved to better align with such preferences.
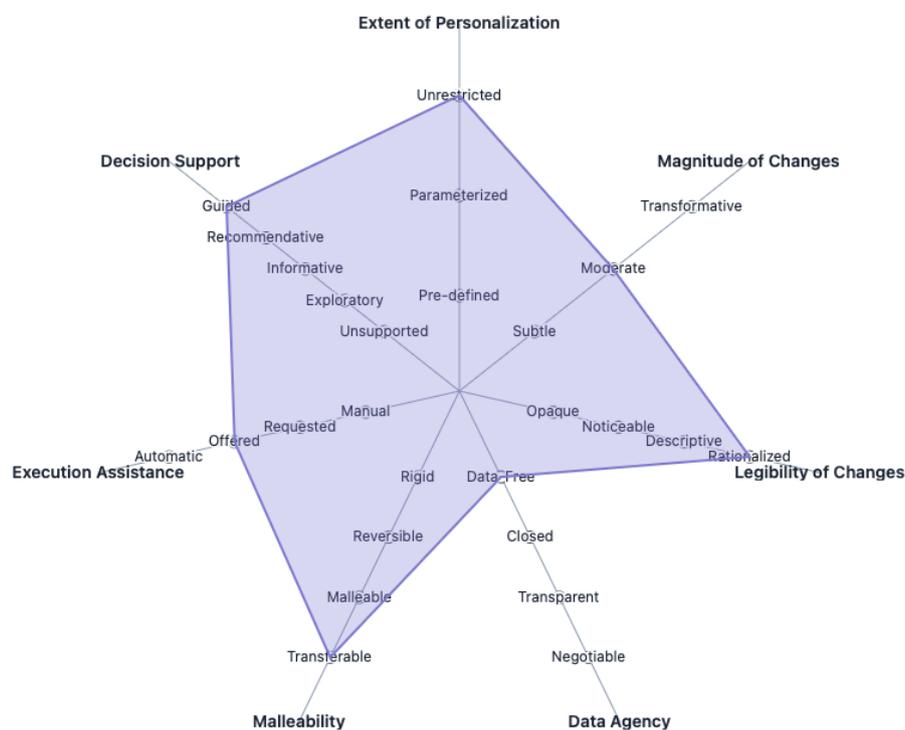
Figure 6.6: Illustration of the characteristics of a UI personalization solution aligned with people's preferences.

Users' Ideal Solution.   People favor personalization software that requires little effort (Sections 3.2.2.4 and 5.2.1.1), including physical and mental effort, raises low privacy concerns (Sections 3.1.2.3, 5.2.1.3 and 5.2.4.3), is non-disruptive or predictable (Section 5.2.2.1), trustworthy (Sections 3.1.2.3, 3.2.2.4 and 5.2.2), and has flexibility for unrestricted redesign and reuse in other contexts (Sections 3.3.1 and 4.2.1). Figure 6.6 illustrates the values of a UI personalization solution aligned with these preferences. Users favor personalization features that are *unrestricted*, *moderate*, *rationalized*, *data-free*, *transferable*, *offered*, and *guided*.

This mapping reflects the preferences of the majority of our participants, though it does not represent all possible perspectives. Furthermore, some preferences are inherently contradictory, and participants demonstrated flexibility for adjusting their choices in beneficial situations, for instance, accepting *negotiable* data agency in exchange for *guided* or *offered* personalization.
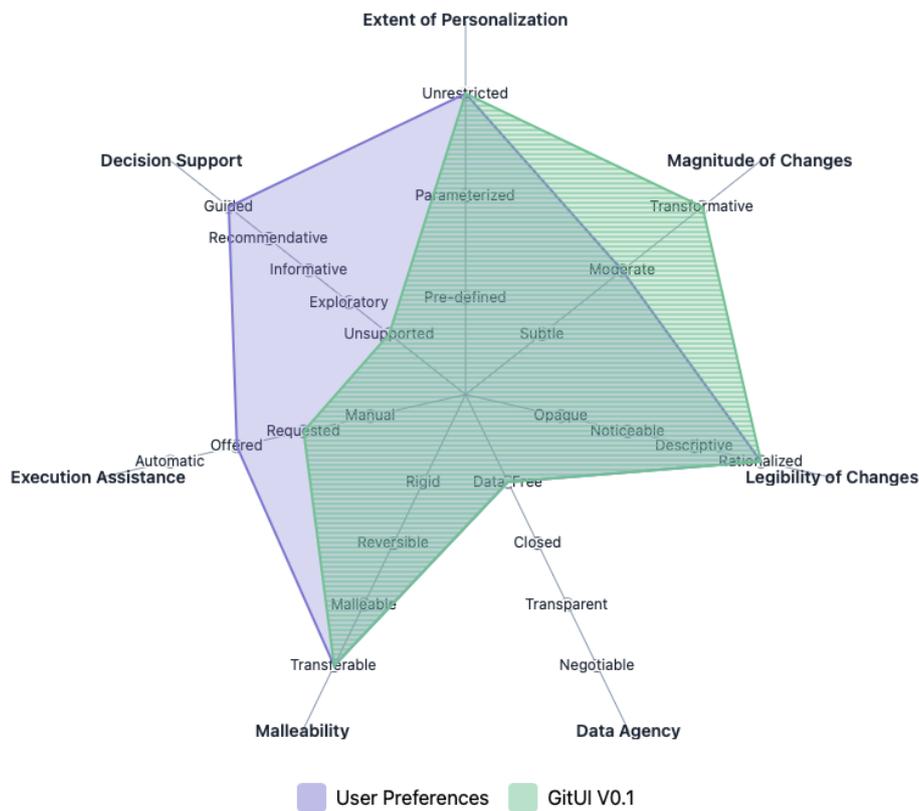
Figure 6.7: Illustration of *GitUI*'s personalization features and user preferences.

Extremes of Personalization.   We can now reflect on how different solutions align with participants' preferences by examining two examples representing opposite extremes in controllability, privacy, and transparency: *GitUI* and *Reflow*. Figure 6.7 illustrates *GitUI* (version 0.1) alongside user preferences. It is noticeable that, while *GitUI* supports *unrestricted*, *rationalized*, *data-free*, and *transferable* personalization, it lacks features that

could further assist users in both the execution and decision-making processes.
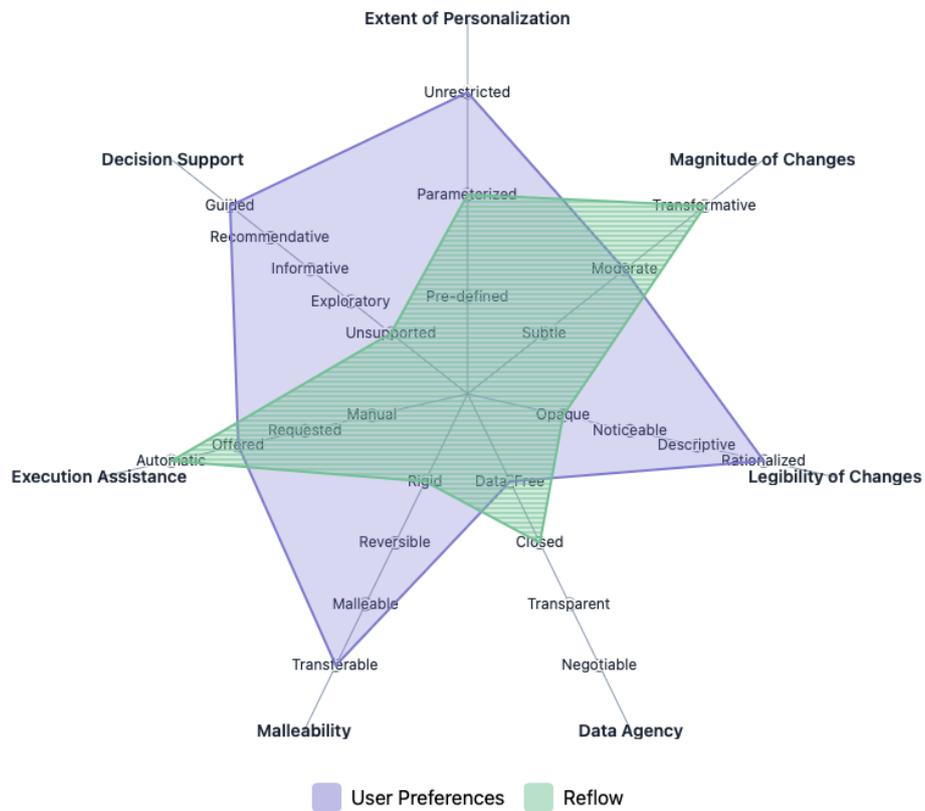
Figure 6.8: Illustration of *Reflow* and user preferences.

In contrast, Figure 6.8 shows that *Reflow* suppresses user preferences regarding execution support, but it does not consider decision support, legibility of changes, or malleability. The system would better align with people's preferences by reducing its assistance to *offered* and the magnitude of changes to *moderate*, while supporting *unrestricted*, *transferable*, and *guided* personalization.
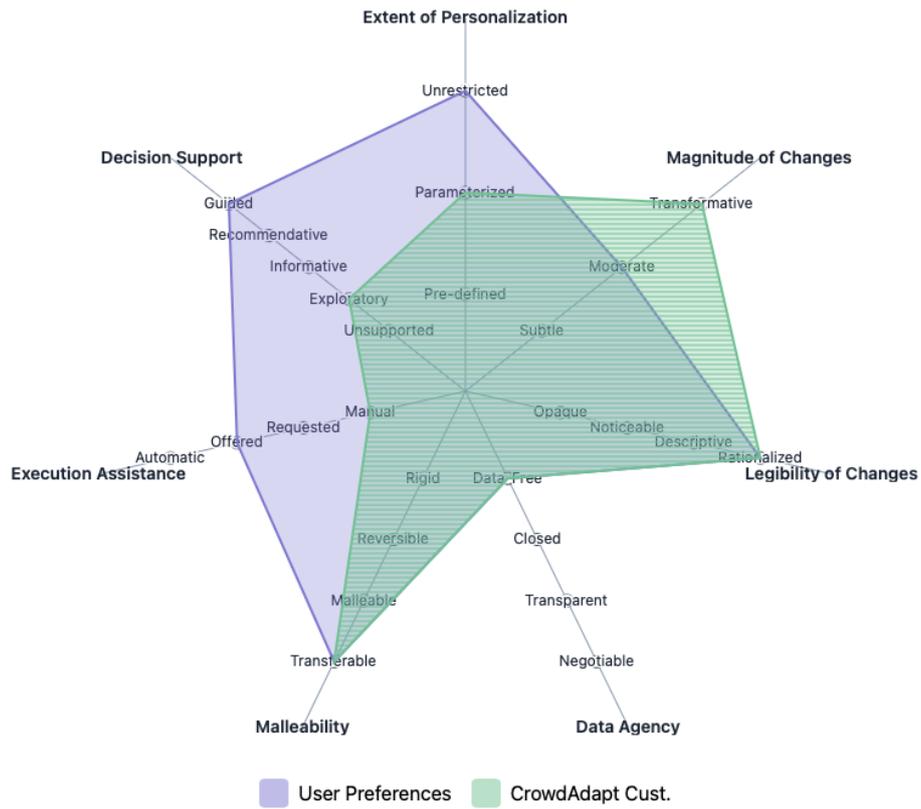
Figure 6.9: Illustration of *CrowdAdapt*'s customization capabilities and user preferences.
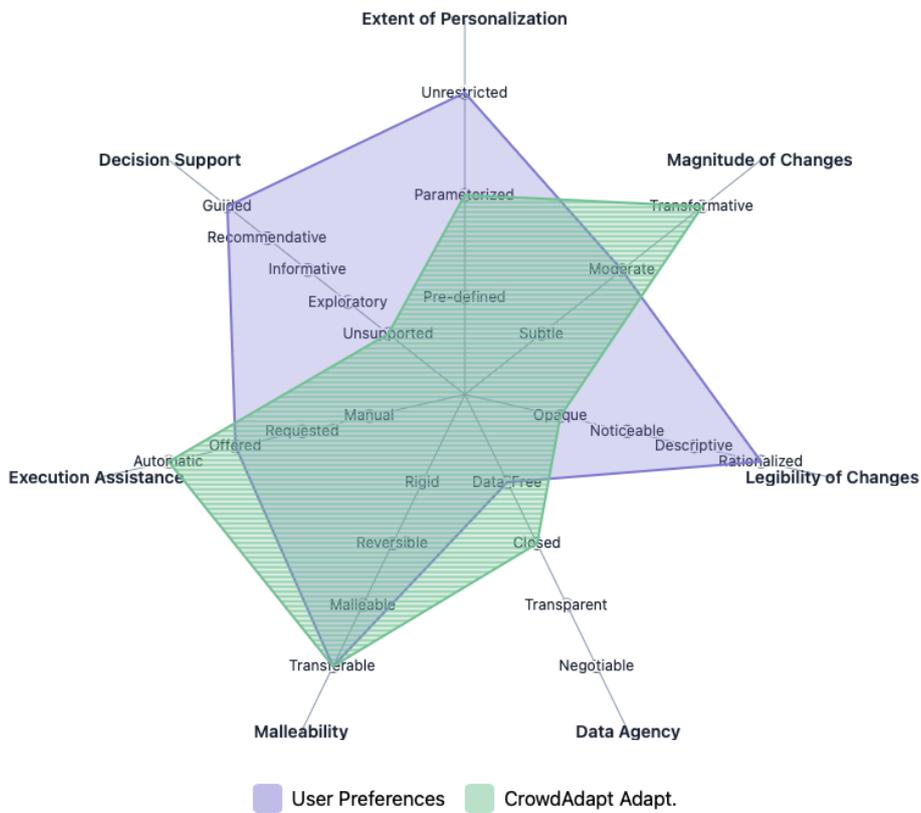
Figure 6.10: Illustration of *CrowdAdapt*'s adaptation capabilities and user preferences.

Evolving Isolated Features. The design space also enables reflection on individual features, which is particularly useful when system functionalities operate in isolation and users experience the tool differently depending on the role they take. One illustrative case is *CrowdAdapt*.

When users engage in UI customization, *CrowdAdapt*'s personalization capabilities can be characterized as *parameterized*, *transformative*, *rationalized*, *data-free transferable*, *manual*, and *exploratory*. Figure 6.9 illustrates how the customization features lack both execution and decision support.

Conversely, when *CrowdAdapt* automatically adapts UIs using crowd-based templates, personalization becomes *parameterized*, *transformative*, *opaque*, *closed*, *transferable*, *automatic*, and *unsupported*. Figure 6.10 highlights that the adaptation capabilities lack legibility, decision support, and data agency.

This analysis allows us to speculate on potential improvements. For example, to make *CrowdAdapt*'s customization capabilities *offered* and *guided*, the system could leverage collected data to suggest public templates or individual changes, either visually or textually. To support *unrestricted* personalization, it could offer code injection or no-code mechanisms, such as AI- or community-based interactions, for implementation of changes.
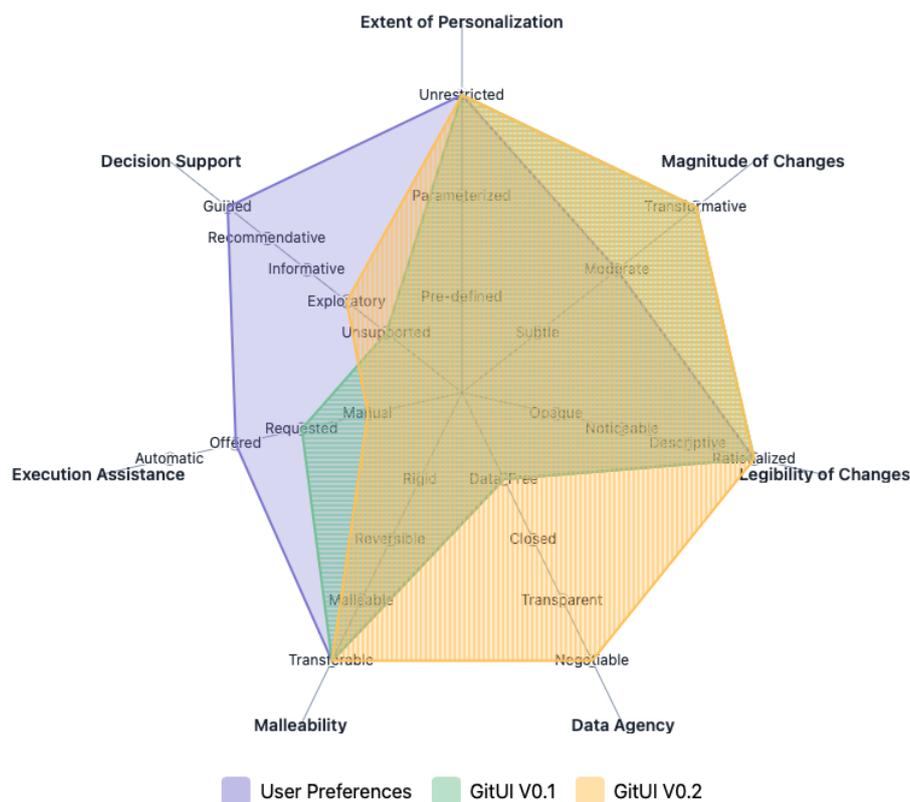
Figure 6.11: Illustration of *GitUI*'s personalization capabilities (versions 0.1 and 0.2) and user preferences.

Evolving *GitUI*.   After completing all studies, we released a public beta of *GitUI* (version 0.2), incorporating several improvements based on participant feedback from Chapters 4 and 5. The updates focused on enhancing the design and user experience, particularly regarding workflow and guidance (e.g., tutorials and tooltips to support users during operations) and resolving existing bugs. Additionally, we introduced data collection and visualization mechanisms, allowing users to consult click and focus heatmaps (highlighting mouse positions) when monitoring is active. Community mechanisms are currently disabled, as our priority is first to establish an active user base capable of publishing templates or assisting others. Considering these changes, we can reflect on how *GitUI* has evolved and identify areas for further alignment with user preferences.

Figure 6.11 represents GitUI versions and user preferences. Version 0.2 is characterized as *unrestricted*, *transformative*, *rationalized*, *negotiable*, *transferable*, *manual*, and *exploratory*. This version represents an improvement over version 0.1 in terms of decision support; however, without community mechanisms, personalization is now fully *manual*.

To better align with user preferences, *GitUI* requires further enhancements in both execution and decision support. Such improvement could be achieved by integrating visual personalization suggestions (discussed in Chapter 5), as well as other associated features that enable users to inspect and control the collected data. This way, *GitUI* would move from enabling passive data analysis to proactively making suggestions and guiding user design decisions. These suggestions should ideally be implemented in a moderated way, allowing multiple non-disruptive changes to be applied simultaneously.

These evolutions highlight how different categories are connected in practice, particularly when used to align systems with user preferences. Not combining them into a solution can have negative repercussions on users' perceptions about such a tool, ranging from their upfront adoption decision to how they engage with it. For instance, providing *recommendative* or *guided* decision support based on collected data should also imply considering a *rationalized* legibility of changes. Similarly, assisting or automating execution implies that the magnitude of changes should be considered. Moreover, these connections often work in cascade. For example, if a system aims for manual personalization, it should provide decision support, which in turn necessitates attention to legibility of changes and data agency.

6.2.3.3   Considering a Novel Solution: Dialogue-Driven Personalization

The design space also enables reflection on solutions that do not yet exist, or may be unlikely to emerge with today's technology. One such speculative case is the use of conversational agents to support UI personalization.

Conversational agents have become mainstream during the period of this dissertation, assisting users in diverse tasks. One such task can be personalization. These systems could partly or fully replace the human assistance envisioned in community-based person-

alization. Recent work demonstrates the feasibility of Human–AI collaboration in layout generation, where natural language descriptions, preferences, or sketches are translated into UI prototypes (Yuan et al., 2024; Xu et al., 2025) or *HTML* and *CSS* code (Patel et al., 2025). However, current large language models (LLMs) still struggle with reliable UI code generation (Wu et al., 2024a), and popular models such as GPT-4 often fail to ensure satisfactory responses to the types of requests we explored in our study. Nevertheless, we can speculate on how such a solution might support personalization, discussing a system in which humans can collaborate with AI to create bespoke personalization templates aligned with their preferences.

The extent of personalization would naturally be *unrestricted*, as any UI element could be adjusted to create personalization templates. Templates could be constructed from elements that users provide, whether through natural language descriptions of their needs or visual cues such as mockups, sketches, or reference UIs (Chen et al., 2021). Over time, users could iterate on these templates, progressively refining them and making them feel more individualized. Moreover, templates would be *transferable*, allowing users to apply them across devices and browsers and share them with others.

Personalization would be *offered* and *guided*. The system may collect interaction data, store conversations, and progressively learn user preferences and goals (e.g., identifying which designs users tend to modify, the reasons behind those modifications, and the alternatives they ideate). With this knowledge, the agent could proactively initiate conversations by suggesting changes. Users, in turn, could engage in a dialog with the agent about why changes are proposed, treating the agent as a reflection companion (Kocielnik et al., 2018) that helps them understand both the modifications and the underlying data. Importantly, users should also be able to initiate such conversations, for instance, when they perceive or anticipate inefficiencies in their behavior. This iterative process, where decisions are discussed, negotiated, and then implemented, would make personalization *offered*, *rationalized*, and *guided*. To ensure trust and control, users must easily be able to access and control the data informing the agent's decisions, making the system *negotiable*.

Suggestions should be presented in a moderated form, offering multiple non-disruptive adjustments simultaneously. This gives users the flexibility to either quickly accept a template or enter a dialog with the agent to refine it further. Manual refinements should always remain possible in cases where the system cannot achieve a satisfactory outcome or the dialogue proves insufficient, ensuring that users remain in control. To support this, users should have access to predefined personalization options and low-level code editing. These options do not need to operate in isolation. Users could still combine them with system support, for example, by visually indicating an element to move and its desired final position, while the system assists in redistributing surrounding elements accordingly.

Human collaboration remains valuable, particularly in supporting manual programming or serving as a source of inspiration. An online repository and community could provide a space where users exchange ideas, share effective AI prompts, and showcase their personal achievements (e.g., resulting templates).

Overall, this speculative system illustrates how conversational agents could mediate personalization as an ongoing dialog, aligning execution, decision support, and community mechanisms with the preferences expressed by our participants.

Chapter 7

Conclusions and Future Work

This dissertation explored how to democratize user interface layouts through personalization. We placed people at the center of the research, using their wishes and needs to guide our investigation. The result is a process that evolved from simply personalizing UIs to studying how to empower people to drive their own personalization, making the process itself more accessible and inclusive, and the resulting changes more meaningful.

This final chapter begins with a summary of the dissertation, connecting the various studies to our original goals. We then provide an overview of the current state of UI personalization, including its evolution over the course of this doctoral research. We conclude by presenting the main benefits and limitations of this dissertation and outlining directions for future work.

7.1 Dissertation Overview

We began in Chapter 1 by outlining the motivation, main goals, and contributions of our research, situated in a context where users have limited agency over how user interfaces are designed, and where meaningful user-driven personalization options for repairing those UIs remain scarce. We also presented the key outputs of this work, including scientific publications aiming at advancing knowledge in UI personalization and the software tool *GitUI*, made available to end users.

In Chapter 2, we started by reviewing design theories that advocate for software systems capable of accommodating user diversity. Nevertheless, such approaches are often considered unrealistic and rarely reflected in the design of today's mainstream systems. We then analyzed the present state of UI personalization, including the factors that shape its understanding and application. In particular, we identified that users are typically restricted to a limited set of pre-defined personalization options or are confronted with complex tools that require expertise and effort beyond the reach of most individuals. Finally, we reviewed past research exploring avenues that can be used to better support users in the personalization process, particularly those exploring community-driven approaches

to reduce skill and effort barriers, and the use of interaction data to inform and guide personalization decisions.

We then conducted four user studies, each with relevant findings to support our contributions and answer our research questions. In Chapter 3, we began by listening to people about their digital experiences and UI personalization's current and potential role in improving those experiences. For the first time, we investigated how individuals engage with an "unrestricted" personalization environment, where any UI component can be changed. Following this study, we explored how their findings expand to a larger population and performed the first analysis of people's personalization practices. From a UI democratization perspective, we believed this process of studying how people envisioned and can make use of increased control and decision-making power over the interfaces they interact with was a key first stage. Our findings revealed enthusiasm for the type of power and control UI customization can offer. However, people's needs were highly diverse and context-dependent, and many demonstrated significant ideation challenges.

In Chapter 4, we proposed the concept of community-based personalization, a novel approach mainly aimed at making UI customization more accessible to non-expert users. This approach is grounded in the idea that the collective effort and distributed knowledge of a community can be combined to produce personalized solutions beyond what a predefined set of options can support, while also delegating the ideation and implementation tasks to others. Over a two-week study, we investigated the dynamics, motivations, and challenges involved in personalizing for oneself, assisting others, and requesting assistance. While people enjoyed volunteering, they rarely went beyond minimal engagement in personalizing for themselves or creating personalization requests. This limited participation reflects people's difficulties imagining how their UIs could be different and better adjusted to their needs. Furthermore, this highlights how the ideation challenges identified in the first study were not only about how to implement personalization, but also about recognizing what UI components need to be personalized in the first place.

In our final study (Chapter 5), we investigated how to support users in recognizing personalization possibilities. Specifically, we explored, for the first time, how interaction data can be placed at users' disposal to support identifying personalization opportunities, the decision-making process, or even system-initiated design decisions about alternative designs. We found that people can independently identify personalization opportunities by exclusively analyzing the data. However, they favor system-initiated guidance that assists them in interpreting the data and making personalization decisions. Importantly, the value of user-driven personalization, where any UI element or personalized UI can be manually adjusted, was never in question. Rather, people simply prefer to have initial support or guidance to help them start the personalization process.

Finally, in Chapter 6, we summarized, discussed, and mapped the findings from our four studies, answering our research questions and proposing a design space. The design

space illustrates characteristics people value and expect from personalization features. We provided examples of how it can be used to visually express the characteristics of existing solutions or support reflection on new personalization features.

7.2   Personalization in an Evolving Landscape

Our work contributes to a research field with decades of history (Kühme, 1993; Myrhaug and Thomassen, 1997; Schneider-Hufschmidt et al., 1993), which has continuously evolved alongside users, interfaces, and devices. To better situate our contribution, this section offers a brief reflection on the historical development of UI personalization.

In the early days of graphical user interfaces (1980s), systems like the *Xerox Star* and *Apple Macintosh* already offered basic personalization options, such as the ability to re-arrange icons (Smith, Irby, Xerox PARC, 1982). Over time, additional personalization features were gradually introduced. For instance, *Windows 3.0* (released five years after *Windows 1.0*) was the first version to let users change the desktop wallpaper (João Carrasqueira, 2024).

Personalization became more perceptible with the rise of personal computing in the 1990s, and aesthetic customization became more common. For example, applications began supporting interface "skins" (Jordan Eldredge, 2020) and Web portals such as *iGoogle* (Udell, 2009), *My Yahoo!*(Manber et al., 2000), or *Hi5* (Funky Llama Productions, LLC, 2006) enabled users to modify layouts, colors, and wallpapers to express their identities.

Since the 2010s, the proliferation of sensor-equipped mobile devices (such as GPS, accelerometers, and light sensors), combined with the centralization of personal data by major technology companies, has enabled personalization to rely on large volumes of collected user data. As a result, both content and aesthetics are now often tailored based on contextual factors (such as location and lighting conditions), usage history, and individual characteristics (Iqbal et al., 2021).

Users have also evolved, becoming more technologically literate as their interactions with computers and user interfaces have increased. For example, beyond the growing population of professional programmers, millions of people now engage in programming-related tasks daily, like writing formulas and queries in spreadsheets and databases (Scaffidi et al., 2005). Additionally, the number of non-professional developers has also been rising, as evidenced by the recent surge in "*citizen developers*", non-professional developers who create applications using low-code or no-code platforms (Chandra Gundlapalli, 2021; Muhammad et al., 2024). Building on these trends, emerging paradigms like *vibe coding* are further lowering the barriers to software creation by enabling users to program through natural language (Li et al., 2025; Sarkar and Drosos, 2025; Bourgault et al., 2025; Anthropic, 2025).

This doctoral program was conducted in a rapidly evolving technological context,

where new personalization features are continuously integrated into the software we use with each update (The Browser Company, 2024; JScherer-WMF, 2024; Thakur, 2025). For instance, since 2024 *Wikipedia* has added an appearance customization panel to its content pages (JScherer-WMF, 2024), facilitating access to personalization options that have been available (though probably unnoticed) for years (Wikipedia contributors, 2025).

This evolution has also been promoted by the *World Wide Web Consortium* (W3C), which in 2019 introduced technical specifications for developing UIs that enable users to adapt web content presentation (W3C, 2019).

Similarly, new browser extensions are published daily, often targeting niche audiences but still enhancing the digital experience of those specific users. Since their early forms as "add-ons" in *Internet Explorer* 4 (1997), the first version of the browser to offer fuller *CSS* support, extensions have become key for web personalization (Schiller, 2021). *Firefox* introduced formal extension support with its debut in 2004, followed by *Chrome* in 2009 and *Safari* in 2010 (Schiller, 2021), helping to popularize extensions. For instance, extensions that restore retro or classic interface themes have attracted thousands of users. Two of the most popular are the *Old Wiki* (adlerzei, 2025) and *Old Twitter Layout* (dimden.dev, 2025), with the latter surpassing 70,000 users.

In contrast, there is still significant room for personalization through third-party software and extensions to grow on mobile devices. Most mobile browsers support few or no extensions, and operating systems typically restrict applications from modifying others. As a result, users often rely on built-in options, such as system themes or accessibility settings. Still, both *Android* and *iOS* have steadily expanded their personalization capabilities. *Android* users can personalize their experience through launchers, custom keyboards, and icon packs. On *iOS*, personalization has also broadened each year, both through accessibility features and system-level personalization options. *iOS* 15 (2021) introduced per-app accessibility settings, enabling users to adjust button shapes, contrast, and font size (Apple Inc., 2022). *iOS* 16 (2022) added lock screen customization with fonts, colors, and widgets. *iOS* 18 (2024) introduced personalized icon colors, positioning, and sizing, as well as the possibility to hide UI elements on *Safari* (Apple Inc., 2024a). *iOS* 26 (2025) allows users to share accessibility settings across devices (Thakur, 2025).

This historical context illustrates how personalization has evolved from simple aesthetic tweaks to more meaningful configurations that reflect users' high-level preferences and needs on third-party software. These developments, along with the evolution of users, reinforce the importance of continuing to expand both what can be personalized and how personalization is achieved. In particular, it is important to re-imagine the role of non-expert users, not as passive recipients of pre-defined templates, but as active participants who are empowered to refine or reshape even the most minor details of their digital environments.

7.3 Benefits

This dissertation provides a user-centered perspective on the role, challenges, and benefits of UI personalization in an era of rapid technological change and evolving resources for users (Section 7.2). It highlights how people wish for more agency over the interfaces they use, how that power can be exercised, and how software developers can provide it, shifting users from passive consumers to active agents and co-producers of the interfaces they engage with (Sections 3.1.2.3 and 5.2.1.4). This resulted in a design space that enables future researchers and practitioners to better consider users' personalization perspectives when designing software (Chapter 6).

To reach this outcome, we began with an in-depth study of personalization needs and preferences (Chapter 3). We found how current personalization offerings remain insufficient to address people's needs. Existing solutions are often constrained to pre-defined options, while less restrictive approaches typically demand availability or expertise that many users lack. Alongside this, we provided a detailed account of existing personalization practices, revealing that a considerable number of people already seek ways to personalize but struggle to find adequate solutions, while many others remain unaware of personalization. In this stage, we also studied the factors shaping people's adoption of personalization mechanisms.

Building on this foundation, we introduced the novel concept of community-based personalization and examined the dynamics of personalization assistance (Chapter 4). We found that while people are often willing to assist others in personalizing, they face significant challenges when attempting to personalize for themselves. These findings demonstrate that true democratization of user interfaces extends beyond merely granting users unrestricted freedom to modify their interfaces. Empowerment arises when users can make informed, independent, and meaningful decisions about themselves and user interfaces. Future work should therefore not only support open-ended personalization but also make it accessible to everyone, provide mechanisms that guide and inform users, and facilitate processes that help them enact changes that matter to them.

In the final study, we showed how interaction data can be used to support personalization by helping users identify meaningful opportunities for change (Chapter 5). We examined people's reactions to different user-driven approaches assisted by the system, exploring the boundaries between acceptable and desirable system assistance versus controllability, effort, and independent decision-making. This resulted in a set of design considerations to guide future solutions aiming to leverage interaction data for user-driven personalization.

Finally, this dissertation proposes a design space intended to support future research and practice in developing personalization mechanisms that align with users' preferences, expectations, and concerns (Chapter 6). More than enabling reflection on technical details, the design space is meant to guide the design of personalization solutions that gen-

uinely empower people to take control of their interaction experiences.

In summary, this work demonstrates that while people wish for more personalization and control, this control must be facilitated. People need to be supported, guided, and often "enlightened" towards discovering personalization opportunities and act upon them. We observed how many people are unaware of personalization, how they struggle to conceptualize changes, or how they are used to default interfaces. Yet, we also observed how they wish to change that and to "learn" how to personalize, to become more proactive in tailoring their interfaces, and to exercise control when they believe or perceive personalization is worth it.

7.4   Limitations

While this dissertation provides in-depth insights into people's hands-on experiences and expectations regarding UI personalization, it also presents limitations and opportunities for future research.

The most significant limitation is the absence of an in-the-wild study where participants engage with personalization over time. Both Chapters 3 and 4 involved only short-term exposure to personalization, while in Chapter 5 this exposure was restricted to design probes. A longer-term study could have revealed different behaviors and preferences and enabled participants to conceive better how personalization might reshape their digital experiences.

This need for extended exploration also applies to the community-based concept. In this dissertation, we focused on investigating its underlying dynamics. Building and maintaining an online community was beyond the scope of this work, due to the time required for developing the software and conducting a longitudinal study, as well as recruitment challenges (e.g., privacy concerns surrounding browser extensions and the diversity of browsers in use). Moreover, further work on the community-based concept would have been premature without first addressing the ideation challenges identified in our studies.3

We also note that, while our design space reflects values identified through discussions with participants, it is not static. It will naturally evolve through future explorations in which both users and experts engage with it to review, expand, or develop personalization solutions.

Finally, this work does not intend to devalue or undermine the work of UI designers. Instead, it seeks to emphasize the importance of empowering users to shape the interfaces they use, whether through the personalization mechanisms we studied or other means. Some participants raised concerns about the protection of intellectual property, and we acknowledge that unrestricted personalization may pose challenges in this regard. We advocate for approaches that deliver personalization in ways that benefit both companies and users.

7.5   Future Work

Our five years of close collaboration with users in studying UI personalization allow us to outline several promising directions for future work. In this section, we address some of them. Across these directions, we emphasize the importance of considering the design space of end-user UI personalization that we propose in this dissertation.

Providing Community-Based Personalization.   We proposed *community-based personalization* to facilitate implementing personalization, through an environment in which people collaborate to create and evolve templates, share knowledge, and obtain inspiration. We studied the dynamics of a personalization process where people can help each other, but ideation difficulties challenged it. While approaches like *dialogue-driven personalization* (Section 6.2.3.3) can be used to address the types of personalization requests people can make, we argue that there remains potential for community-based solutions.

Communities can play a vital role when personalization agents fail, or when users seek aesthetic-focused changes or creative solutions for their problems. More importantly, they can offer a space for users to express and demonstrate their needs and solutions openly. These public contributions could also inform the original UI creators, providing insights into changes that should be included in their systems.

Therefore, future work can further explore the community concept, integrating features such as gamification and communication channels, while also supporting users in identifying, articulating, and understanding personalization opportunities and the value of personalization itself.

Meaningfully Empowering Users by Combining Personalization and Interaction Data.   Although many personalization solutions exist, few truly empower any user to meaningfully change their interface while feeling confident that those changes are worthwhile. Our work showed how people value being supported in identifying which changes are possible, provided with clear explanations about why changes might be beneficial, and assisted in actually implementing those changes (Chapters 4 and 5). These findings highlight an important direction for future software development, regardless of whether it is more aligned with user- or system-driven principles.

We see a key opportunity for future work to build on this by developing systems that (1) offer transparency and controllability over interaction data, (2) enable open-ended personalization, and (3) provide guidance and assistance to help users act on insights from their own data.

Personalization for Different Forms of Interaction and Triggers.   Building on our findings, future work can explore how similar principles apply to personalization beyond

traditional graphical UIs, such as conversational agents and rule-based personalization systems.

Conversational agents offer a distinct mode of interaction. Instead of navigating menus or browsing websites, users engage with a single conversational entry point, phrasing requests in natural language to access information or perform tasks. This shift introduces new opportunities for personalization. Interfaces of conversational agents become a single focal point for personalization, where the emphasis moves beyond layout changes toward tailoring the content and responses of the agent.

This also implies a shift in the triggers of personalization. While layout personalization is often motivated by structural considerations (e.g., reorganizing menus), in conversational agents, personalization is more likely driven by the types of content. We already observed this tendency in Chapter 3, where layout personalization often depended on the nature of the content. For example, when *Wikipedia* displayed a band's discography, participants were interested in adding album covers, a personalization that only applies to one type of content. We also believe that personalization in conversational agents will reduce the need for users to manually redesign interfaces, while opening avenues for verbal personalization requests similar to those explored in Chapter 4.

Future work should investigate how the motivational factors and forms of assistance discussed in this dissertation extend to conversational agents. One promising direction is leveraging conversational data to enable agents and users to negotiate new ways of presenting information and content.

A second direction to explore our findings concerns rule-based personalization, such as *If This Then That* mechanisms (ITTT, 2025), which allow users to adapt the behavior of objects or services based on triggers. Similar to UI personalization, engaging with these setups can be motivated by efficiency or controllability and challenged by privacy. Interaction data could play an important role in helping users define rules by helping them identify meaningful triggers, patterns, and routines. For example, people could learn from patterns such as how often they turn on the TV or the lights when arriving home. Importantly, making such data transparent and controllable could also mitigate privacy concerns.

Overall, although these novel approaches broaden how people can access and personalize information, they do not fully cover the diversity of content people engage with, such as social media or multimedia platforms, which remain highly visual. This leaves space for the forms of personalization discussed in this dissertation to remain relevant and to be explored further in other contexts.

Reconsidering Roles in UI Design. This dissertation highlights the importance of reconsidering end-users' roles in shaping the interfaces they use. In many digital services today, value lies primarily in data. Interfaces function as representations of this data, but

their form is controlled by service providers, who naturally aim to maximize engagement through mechanisms such as algorithmic feeds and recommendations (Wu et al., 2022; Bucher, 2017; Montag et al., 2019). While such control benefits providers, it can limit users' agency or, even more significantly, compromise accessibility. At the same time, enabling users to influence how data is presented may also serve providers' interests, for example, by increasing website stickiness (Benlian, 2015).

Future work can explore mechanisms that balance these competing interests, granting users more meaningful control without undermining service value. One promising direction lies in extending concepts like meta-design (Fischer and Scharff, 2000; Fischer et al., 2004). Instead of treating original interfaces as fixed endpoints, they could be viewed as flexible templates that users are empowered to adapt or replace. In such a model, developers provide a default design, while users are supported in creating or adopting alternative templates, potentially informed by their own interaction data (an aspect not considered in meta-design). This shift would move the design process from being solely developer-driven toward a more democratic model, where users gradually "learn" personalization and take a more proactive role in shaping the interfaces they use.

Glossary

Adaptability A system's capacity to be customized by a user. 167

Adaptable User Interface A user interface intentionally designed with built-in user-driven personalization features that support Adaptability, allowing users to modify predefined settings to adjust its appearance, behavior, or functionality. 2, 17

Adaptation Software System-driven personalization software installed to automatically adapt external user interfaces in response to user behavior or contextual changes. 3, 17

Adaptive User Interface A user interface intentionally designed with built-in system-driven personalization features that support Adaptivity, automatically adapting itself to user behavior or contextual changes. 2, 17

Adaptivity A system's autonomous capacity to adjust itself. 167

Agency The capacity to act or exert power. In the context of user interfaces, this includes users' ability to act (e.g., personalize the UI) and their perceived sense of control and influence over the decisions they make. 3, 5

Community A group of people united by common interests, goals, or social connections. 4, 23

Community-Based Activities, components, or software that are driven by or developed by the members of a community, often involving collaboration or collective decision-making. 6, 29, 71

Customization The user-driven process of modifying a user interface. 167

Customization Software User-driven personalization software installed to enable users to customize or repair external user interfaces directly. 3, 17

Democracy A system of governance in which power is vested in the people. Democratic principles can apply to organizations and groups whose members all have the right to participate in decision-making and have their opinions heard. It is founded on

the principles of freedom and equality, in which power is either held by elected representatives or directly by the people themselves. 1

Interaction Data Recorded information (i.e., logs) about how users engage with an interface, including actions such as clicks, mouse movements, scrolls, and keystrokes. 2, 7, 100

Mixed-Initiative Personalization Software Personalization software that is neither fully user-driven nor entirely system-driven. It often combines system-driven personalization and user control, allowing users to guide or refine the system's personalization. 17

Personalization The act of making a user interface suitable for the needs, preferences, or requirements of an individual or a group. 1

Personalization Template An instrument that contains a series of personalization instructions. It can be used as a sample document or as a reference for producing other similar templates. 6, 71

System-driven Personalization A personalization process automatically executed by the system without direct user input or control. 3, 16

User An individual who interacts with a user interface. 1, 8

User Interface A two-dimensional (2D) visual and interactive layer of a digital system that intermediates interactions between users and software or devices, such as smartphones and laptops. 1

User-driven Personalization A personalization process that is performed under direct user input or control. 3, 16

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Appendix A

Study 1

A.1 Diary of Web Experiences to Report Opportunities to Improve User Interfaces (English Version)

My Diary of Web Experiences

This form is a means to report relevant experiences on the websites you usually visit, including unpleasant situations, problems you would like to fix, or improvements to the interfaces. If you have experienced one of these situations, please enter the details below.

* Indicates required question

1. Participant ID: *

2. Website (please insert the website name or the link to the page): *

3. Please describe the experience/problem you encountered and why. *

4. Did this experience occur in a specific context? *

5. Representative image of the experience (Optional):

Screen capture tips: https://support.microsoft.com/en-gb/help/4028673/windows-keyboard-shortc for-print-screen (windows) or https://support.apple.com/en-gb/HT201361 (macOS)

Files submitted:

6. Is this an experience that occurs in other pages or websites with the same structure? *

Mark only one oval.

⬭ Yes

⬭ No

⬭ Maybe

A.2   Script for Co-Designing Web Personalization

Exploration of Web Personalization Script & Recommendations

1. Start by introducing yourself and thanking participates in the study:
   a. "Hello. Thank you again for participating in this study. The purpose of today's meeting is for us to sit down together and have the opportunity to modify, and hopefully improve, the websites that you reported as needing a redesign. This session is expected to last 1 hour. At any time you are free to give up. If you need a break feel free to let me know.";
2. Fill the CRF;
3. Perform a 1-hour (max) participatory design session:
   a. "Now let's move on to the most interesting part. We will try to solve the needs you previously reported and to adapt the websites you use to your personal likings. I want you from now on to imagine that we are a team with this goal of improving the websites you use. We will be looking at the same screen at the same time. I will share my screen with you and all the changes will be made on my computer.

   When we finish with the changes, and you approve them, you can interact with the website from your computer. In this way we guarantee that you do not need to install anything on your computer or provide any personal data during this session.

   Let's get started. **There is only one rule: there are no rules!** I want you to think that any change is possible. As crazy as the idea may be or even difficult to imagine on the screen, I want you to share it with me and we will be able to start gradually building a sketch that you enjoy. I ask you to **forget all the preconceived ideas** that you have about websites (e.g., the menu doesn't always have to be at the top of the screen) and to **feel like a real designer**. The end result does not need to work well for others but for you. Please note that I may not be able to make all the changes today, but we will register them as something that users would like to do. I propose that we start by thinking about the experiences that you reported to us and from there we try together to find a solution."

   b. For each of the websites to personalize:
      i. Clarify the reported experience – understand the problem and try to find a solution;
      ii. Elicit participants to provide suggestions even if they enjoy the current version of the website or all the reported problems are solved. Use the below probing challenges to start a topic but delve deeper when the participants have something more to say;
      iii. Don't ask questions that have already been answered by the participants;

       iv.   When the answers are not satisfactory in detail, find alternative questions, to collect information;

       v.   Make the participants talk, not you.

       vi.   Don't be afraid of silences. Silences are good; they make the participants think and delve deeper. Don't rush.

4. Thank the participants and invite them to use the personalized version of websites:

    a. "Once again thank you very much for participating in this study, we will like to invite you to use your personalized version of the websites. I'll share a link with you and you just need to install an extension to access your data."

Probing challenges

- What would you change in the structure?
- What about the colours?
- Would you benefit from a shortcut to a specific page?
- What is the most important information to you on this page? Do you think it is well positioned?

A.3 Focus Group Script

Focus Group Script

Before the Workshop

1. Prepare a workspace summarizing the main topics/experiences reported by participants in the previous phases of the study:
   a. Make a list of these topics.
   b. Create a digital workspace for the session (e.g., in mural.co or miro.com).
   c. Add each list item (from 1.) as a note on the wall/workspace, in no order.
   d. Create a few category names, based on the notes. Common categories are: Search, Global navigation, Homepage, Legibility, Footer, Page layout. Stick these category names high on a blank part of a wall (so other notes can fit below).
   e. Add an image to each note showing the solution found.
   f. Sort the notes into Top-Level Categories.

2. Prepare a list of vignettes to address the other problems/topics:
   a. Each vignette will consist of a story (containing a persona, a context and the challenge), a representative image of the challenge and a set of questions or discussion topics to address the challenge.

3. Prepare a list of vignettes to show up how UIs can be augmented:
   a. The vignettes will have the same structure.
   b. Create reliable stories addressing advanced personalization functionalities, e.g.:
      i. Personalize page content based on personal history.
      ii. Data sharing between different websites.
      iii. Personalize the Web by adding a set of triggers and actions (If This Then That model).

To start of the Workshop (~10min)

1. Start by thanking participates in the study:
   a. "Hello. Thank you again for participating in this study. The purpose of today's meeting is for us to sit down together and have the opportunity to have a healthy discussion between us about (1) what me and you learned with the participation in this study; and (2) in what direction should research move in order to improve current interfaces. This session is expected to last 1 hour. At any time you are free to give up. If you need a break feel free to let me know.".

2. Fill the CRF.

3. Announce the Steps and Timing Guidelines:
   a. "The session will be divided into 3 parts. First, we will focus on what was reported by participants as challenges and what were the solutions found. Then, we will talk about more complex challenges that couldn't be solved. In the third part I will introduce some new ideas to augment UIs."
   b. "From now on I will share my screen so we can use these cards that I have prepared to guide the session. Any questions?"

Focus Group Script

Part 1 - Reflect About Solved Experiences (~15min)
1. Introduce this part:
    a. "First, I created a workspace, which is like a wall. Each note represents a personalization opportunity, previously reported by one of our participants, and is associated with a category. Together with these opportunities we have the solutions.".
2. Ask participants about their interest in a specific topic:
    a. "Are any of you curious about one of these topics?"
3. If needed, suggest two/three topics to address:
    a. Ask participants if they encounter similar experiences or they can think of a different solution.

Part 2 - Reflect About Unsolved Experiences (~15min)
1. Introduce this part:
    a. "For the second part of the session I created these cards. Each card contains the story of an unsolved personalization opportunity and some questions and topic suggestions for our discussion.".
2. Ask participants about their interest in a specific topic:
    a. "Is there a card that stands out for you?"
3. If needed, suggest two/three cards to address:
    a. Use the questions on the vignette to start the discussion.
    b. Ask participants if they encounter similar experiences or they can think of a solution.

Part 3 - Reflect About Interfaces Augmentation (~20min)
1. Introduce this part:
    a. "For the third part of the session we will deal with more advanced solutions for some of the reported experiences. Each card contains the story of an experience, the questions and topic suggestions for our discussion, and a solution. The difference is that these experiences and solutions are more complex and require more knowledge about the users and the interfaces.".
2. Ask participants about their interest in a specific topic:
    a. "Is there a card that stands out for you?"
3. If needed, suggest two/three cards to address;
4. Ask them if they can think of more complex needs or if they think they can apply any of these solutions to improve their experiences.

End the Session
Thank the participants:
1. "Once again thank you very much for participating in this study."

A.4 Online Workspace

Part 1: Solved Problems

Part 2: Unsolved Problems

Part 3: Augmented personalisation

Part 4: Design task

Part 1: Solved Problems

Agilidade

http://news.google.com
Quando vou ao google notícias, é quase automático eu ir para o fim da página, pois as notícias de saúde estão sempre em baixo. No entanto, o desporto (futebol) vem sempre primeiro.

http://gameplay.pt
Remover banner que inclui o "slogan" da loja - "Jogos + Pessoas = Possibilidades"). Gostava que na primeira página fossem apresentadas as promoções em vigor.

http://boardgamegeek.com
Gostava de conseguir aceder à minha Collection e Wishlist apenas com um clique (ter botões no cabeçalho, por exemplo).

https://pt.wikipedia.org/
A página de cada banda devia listar os álbuns de estúdio de uma forma mais prática, por exemplo numa coluna à parte. Idealmente com a imagem de cada capa

http://boardgamegeek.com
A informação na página inicial é pouco interessante

Estética

https://www.popandplay.pt/
Design feio e cores que não contrastam bem. Alinhamentos muito mal feitos.

https://mediamarkt.pt/
Acho que o site é esteticamente desagradável e é overwhelming tentar ler a homepage.

Ordenação/Filtragem

https://boardgamegeek.com
Quando entro na minha coleção, gostava que aparecessem apenas os jogos que possuo realmente na minha coleção. O que acontece é que também lista jogos na minha wishlist (jogos que gostaria de ter)

Part 2: Unsolved Problems

Card 1

Persona, Context and Challenge

"O botão para anexar ficheiros está num canto superior da janela, o que vai contra o que é habitual noutras aplicações e na própria versão app do Whatsapp para smartphones. Acho que também seria prático haver um botão à parte próprio para enviar imagens."

K

Representation

W

Questions

- Com que frequência se deparam com este tipo de problemas?

- Conseguem encontrar problemas parecidos?

- Qual acham que seria a melhor forma de fazer esta integração web-mobile?

L

Card 2

Persona, Context and Challenge

"Não há uma categoria para jogos de tabuleiro. Acho que faz sentido haver uma categoria para jogos de mesa e outra para jogos didáticos/brinquedos. Quando vou à procura de jogos nestas lojas online, nunca chego ao que quero num clique por causa disso."

"Acho que, com base em compras anteriores/produtos vistos, podia ter uma página inicial com produtos recomendados."

K

Representation

W

Questions

- Este é um tipo de problema que também costumam ter?

- Conseguem encontrar problemas parecidos?

- Como acham que este tipo de menu de navegação por categorias poderia ser melhorado?

L

Card 3

Persona, Context and Challenge

"Num mundo digital cada vez mais rápido e digital, sites como este requerem imenso tempo de pesquisa. Idealmente, gostaria que houvesse um botão para activação de reconhecimento de voz."

"O Google não reconhece range de números. Não sabe analisar um texto e reconhecer que números são relacionados a horas, datas, velocidade, peso etc Logo, eu não consigo fazer pesquisas do género: maratonistas olímpicos que possuam uma velocidade de 14km/h, na prova de 10 km, entre 1980 e 1990."

K

Representation

W

Questions

- Este é um tipo de problema que também costumam ter?

- Conseguem encontrar problemas parecidos?

- Como acham que as pesquisas dos websites poderiam ser melhoradas?

Part 3: Augmented personalisation

Card 1

Persona, Context and Challenge

Pedro — Gestor de Projetos — 28 anos

"Viajo frequentemente para Madrid, onde a minha empresa está sediada. Gostava que me fossem apresentados de imediato os melhores preços de voos para Madrid na página inicial."

Solution

O sistema tem acesso à estrutura da página e ao histórico do utilizador e personalização a página baseada nesse histórico.

Questions

Conseguem pensar em outros problemas onde aplicar esta solução?

Quais os benefícios e limitações que vêm nesta solução?

Card 2

Persona, Context and Challenge

Pedro — Gestor de Projetos — 28 anos

"Quando quero fazer uma viagem e visito diferentes sites (hotéis e voos) tenho de estar constantemente a selecionar a data e local."

Solution

Partilha de informação entre diversos websites. Desta forma o sistema apresenta imediatamente voos ou hotéis para aquele local e data.

Questions

Conseguem pensar em outros problemas onde aplicar esta solução?

Quais os benefícios e limitações que vêm nesta solução?

Card 3

Persona, Context and Challenge

Pedro — Gestor de Projetos — 28 anos

"Quando quero fazer uma viagem e visito diferentes sites (hotéis e voos) tenho de estar constantemente a selecionar a data e local."

Solution

Conjunto de triggers e ações que permite a criação de um workflow. Desta forma ao selecionar um voo o sistema apresenta de imediato uma lista de hotéis para aquele local e data.

Questions

Conseguem pensar em outros problemas onde aplicar esta solução?

Quais os benefícios e limitações que vêm nesta solução?

Card 4

Persona, Context and Challenge

Catarina — Enfermeira — 33 anos

"A minha tarefa nos hospital é adicionar novos pacientes ao sistema. Necessito sempre de efetuar vários cliques para chegar à página necessária."

Solution

O conteúdo das páginas Web adapta-se automaticamente aos objetivos do utilizador. Os objetivos são definidos pelo utilizador ou captados automaticamente.

Questions

Conseguem pensar em outros problemas onde aplicar esta solução?

Quais os benefícios e limitações que vêm nesta solução?

Appendix B

Study 2

B.1 Online Survey (English Version)

Study 2 — Online Survey

The goal of this questionnaire is to try to understand what changes (from the aesthetic and functional perspectives) users make or would like to make in the applications, websites or programs they use. Basically, trying to understand how common citizens personalize, or would like to personalize, their devices and applications. Please note that you need to be a smartphone/tablet and desktop/laptop user to participate in this study.

This questionnaire is divided into four parts. First, we will try to get to know you better, then to understand how you use your smartphone and/or computer, and finally, we want to know your opinion about some scenarios that we will propose.

Your participation in this research is voluntary. You have the right to withdraw at any time during the study, for any reason, and without any prejudice. We will follow all ethical and legal practices and all information about you will be treated in a confidential manner.

By clicking the button bellow, you acknowledge that your participation in the study is completely voluntary, you are at least 18 years of age, and that you are aware that you may choose to terminate your participation in the study at any time and for any reason.

* Indicates required question

1. Please indicate your consent before proceeding: *

   Mark only one oval.

   ( ) I consent, begin the study

   ( ) I do not consent, I do not wish to continue   *Skip to section 14 (Do not consent)*

Before you start

2. Are you a regular user (at least 2 hours a week) of any of these devices? *

Mark only one oval.

( ) Mobile devices (smartphone or tablet)   *Skip to section 15 (Unable to participate)*

( ) Personal computers (desktop or laptop)   *Skip to section 15 (Unable to participate)*

( ) Both: mobile devices and personal computers

( ) None   *Skip to section 15 (Unable to participate)*

Let's get to know you better.

We want to know a little more about you.

3. Please enter your Prolific ID: *

_____

4. Age *

_____

5. Gender *

Mark only one oval.

( ) Male

( ) Female

( ) Prefer not to disclose

( ) Other: _____

6. Country of residence *

_____

7. Highest level of education completed *

   Mark only one oval.

   ( ) Primary education, elementary school or equivalent

   ( ) Secondary Education, high school or equivalent

   ( ) Bachelor

   ( ) Master's

   ( ) Doctorate

   ( ) Other: _____

8. Profession *

   If retired or unemployed, indicate your last profession. If a student, also indicate your academic area

   _____

9. Do you identify yourself as having some kind of disability? *

   Mark only one oval.

   ( ) No   *Skip to question 11*

   ( ) Visual

   ( ) Auditory

   ( ) Motor

   ( ) Cognitive

   ( ) Other: _____

   Let's get to know you better

10. Do you want to specify?

_____

_____

_____

_____

_____

Let's get to know you better

Regarding your physical and psychological capabilities, from 1 to 5 indicate the degree of difficulty that each of these actions represents...

11. Seeing words or letters (with glasses, if you usually wear them) *

   Mark only one oval.

	1	2	3	4	5	
No difficulty seeing	◯	◯	◯	◯	◯	Unable to see

12. Hearing what is normally said in a conversation (with a hearing aid, if you usually wear one)

   Mark only one oval.

	1	2	3	4	5	
No difficulty hearing	◯	◯	◯	◯	◯	Unable to hear

13. Interacting with a touch sensitive screen *

Mark only one oval.

	1	2	3	4	5	
No difficulty interacting	◯	◯	◯	◯	◯	Unable to interact

14. Interacting with a mouse or keyboard *

Mark only one oval.

	1	2	3	4	5	
No difficulty interacting	◯	◯	◯	◯	◯	Unable to interact

15. Concentrating, remembering or making decisions due to a physical, mental or emotional condition

Mark only one oval.

	1	2	3	4	5	
No difficulty concentrating	◯	◯	◯	◯	◯	Unable to concentrate

Tell us your perspective.

We want to understand your general view about the role of developers and users in software development.

From now on, think about the applications, programs or websites that you interact with on a daily basis.

16.   How critical are you about the applications/websites you use? *
      Critical regarding the interface design or the features that the application provides.

      Mark only one oval.

      ◯ Nothing critical. I use the applications as they are and do not even think about how they could be improved.

      ◯ A little critical. I use the applications as they are, but sometimes I would like to be able to change some aspects.

      ◯ Very critical. There are some aspects that bother me and if I were the one developing the application I would do it differently.

      ◯ Critical and interventional. When I do not like something, I try to fix the problem.

      ◯ Other: _____

17. How interventional are you, in terms of aesthetic and functional changes, in the applications/websites you use?

Interventional in terms of adjusting the interface to your preferences.

Mark only one oval.

◯ Nothing interventional. I use the applications as they are.

◯ A little interventional. When allowed, I change small things such as background images or themes (dark or light) of applications or websites.

◯ Interventional. I often search for tools or extensions to change some aspects.

◯ Very interventional. Sometimes I develop small scripts to change applications.

Regarding your use of mobile devices

Let's start by understanding how you use your mobile device.
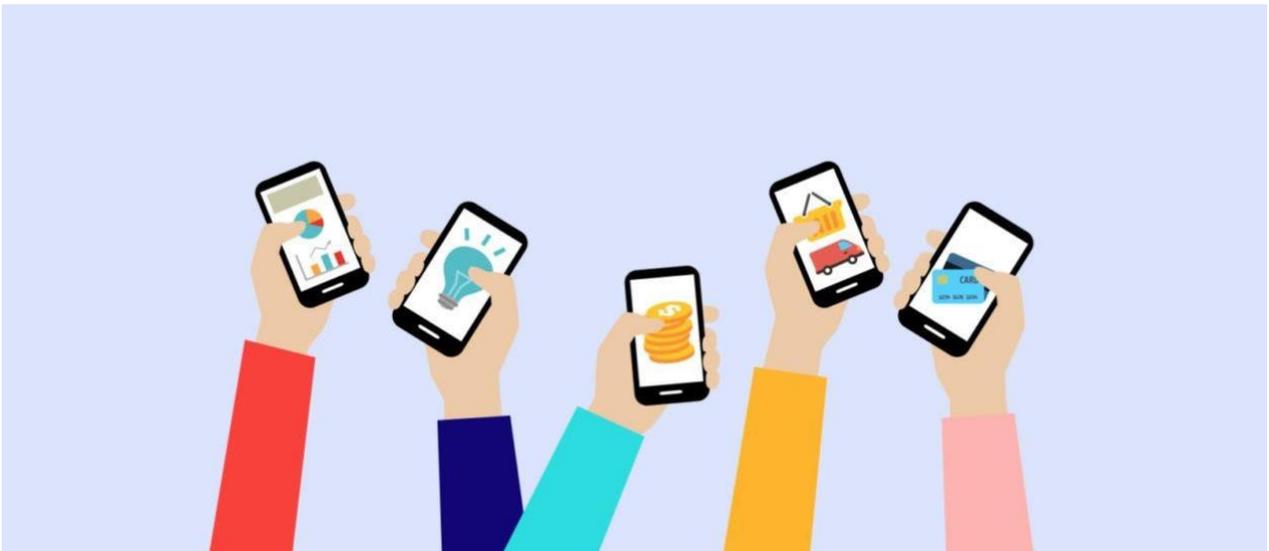
18. Which of these do you use most often? *

Mark only one oval.

◯ Smartphone

◯ Tablet

◯ Other: _____

The questions in this section refer to the mobile device you use the most (indicated above).

19. What is your device's operating system? *

Mark only one oval.
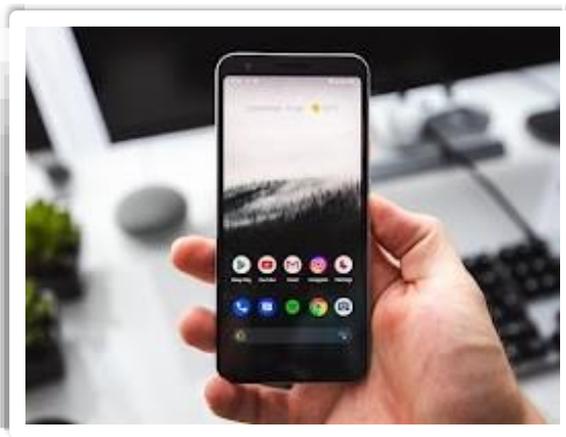
◯ Android (Google)

◯ iOS (Apple)

◯ Other
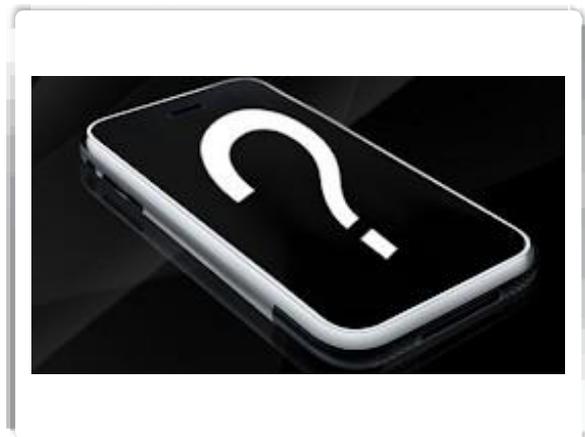
◯ I don't know

20. Approximately, how long have you been using a smartphone or tablet (in years)? *

_____

21. On average, how many hours a day do you spend using a smartphone or tablet? *

_____

Regarding your use of mobile devices

Now we want to know your opinion regarding the interfaces of the applications you use on your mobile device.
Remember, the interface is the environment for interaction between the user and an operating system, which represents programs, files and options through icons, menus or dialog boxes.

In general, and regarding the interfaces of the applications that you usually interact with, from 1 5 indicate...

22. What do you think of the text size? *

Mark only one oval.

	1	2	3	4	5	
Nothing adequate	◯	◯	◯	◯	◯	Totally adequate

23. What do you think of the size of the images? *

Mark only one oval.

	1	2	3	4	5	
Nothing adequate	◯	◯	◯	◯	◯	Totally adequate

24. What do you think of the size of buttons and other interactive elements? *

Mark only one oval.

	1	2	3	4	5	
Nothing adequate	◯	◯	◯	◯	◯	Totally adequate

25. What do you think of the contrast between colors? *

Mark only one oval.

	1	2	3	4	5	
Nothing adequate	◯	◯	◯	◯	◯	Totally adequate

Still about the applications you usually use. Indicate how often you encounter the following situations. Being 1, never and 5, always.

26. How often do you find disorganized or confusing menus? *

Mark only one oval.

	1	2	3	4	5	
Never	◯	◯	◯	◯	◯	Always

27. How often do you find interfaces with more information than you need? *

Mark only one oval.

	1	2	3	4	5	
Never	◯	◯	◯	◯	◯	Always

28. If you are reading this, please answer 2. *

Mark only one oval.

	1	2	3	4	5	
Never	○	○	○	○	○	Always

29. How often do you find interfaces with more features than need? *

Mark only one oval.

	1	2	3	4	5	
Never	○	○	○	○	○	Always

30. How often do you find interfaces that are not adapted to your needs or interests? *

Mark only one oval.

	1	2	3	4	5	
Never	○	○	○	○	○	Always

31. Do you want to comment?

_____

_____

_____

_____

_____

Thinking now of ways to adapt the interface to your needs and interests, from 1 to 5 indicate...

32. How important would it be for you to have control over the design/layout of application interfaces?

For example, control sizes, fonts, colors or elements order.

Mark only one oval.

	1	2	3	4	5	
Nothing important	◯	◯	◯	◯	◯	Very important

33. How important would it be for you to have control over the features or behavior of applications?

For example, change existing features or add new ones.

Mark only one oval.

	1	2	3	4	5	
Nothing important	◯	◯	◯	◯	◯	Very important

34. Can you give examples of changes you would like to make?

Try to think about how you would adapt an interface to achieve a better user experience. Think about interaction problems you may have and how to fix them.

_____

_____

_____

_____

_____

Regarding how you personalize mobile devices interfaces

Personalize means to make something suitable for our needs and preferences.

Mobile devices software offers some options for personalizing the interface. For example, it is possible to change the shape of application icons or the text size and font type. In this section we want to know more about how you adapt the interfaces to your personal liking.
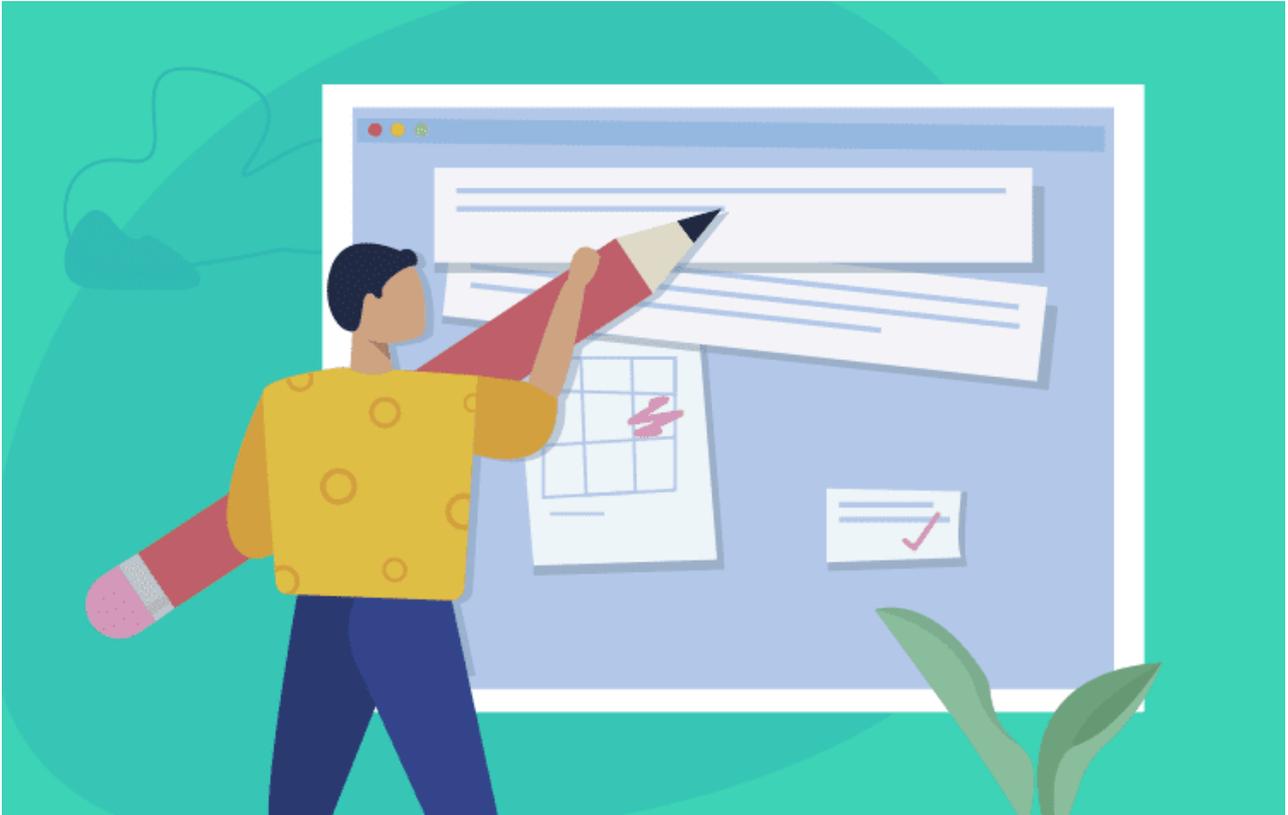
Regarding how you adapt your device to your personal liking.

35. Have you ever changed the shape or size of icons on your device? *
     You can for example change the size or shape of application icons.

     Mark only one oval.

     ◯ Yes
     ◯ No
     ◯ I didn't know it was possiblel
     ◯ don't know how to answer

36. Have you ever changed your device's background image? *

You can change the image that appears in the background of your applications list or home screen

Mark only one oval.

○ Yes

○ No

○ I didn't know it was possibleI

○ don't know how to answer

37. Have you ever changed the text size or font type of your device? *

Through the settings it is possible to make the text larger or smaller or change the font.

Mark only one oval.

○ Yes

○ No

○ I didn't know it was possibleI

○ don't know how to answer

38. Have you ever changed the color mode of an application? *

For example, some applications allow you to switch from a lighter theme to a darker (mainly affecting the colors), and vice versa.

Mark only one oval.

○ Yes

○ No

○ I didn't know it was possibleI

○ don't know how to answer

39. Have you ever changed your device's launcher? *

Launcher is a type of application that changes the Android home page and application list.

Mark only one oval.

◯ Yes

◯ No

◯ I didn't know it was possiblel

◯ don't know how to answer

◯ Not applicable

In addition to the changes described above, there are also other applications that allow for deep personalizations. For example, changing the keyboard and its colors or creating automated task and actions.

40. Have you ever searched for applications or tools that would allow you to somehow adapt your device?

For example, an application that enlarges the screen.

Mark only one oval.

◯ Yes

◯ No

◯ I don't know

41. Do you have any such application, that personalize your device, installed? If not, why?
Have you tried one? If so, which and why?

For example, applications that change the font color and size, that change the layout of icons, etc.

_____

_____

_____

_____

_____

Regarding your use of computers

42. What operating system do you use? *

Mark only one oval.

○ Windows

○ Mac OS

○ Linux
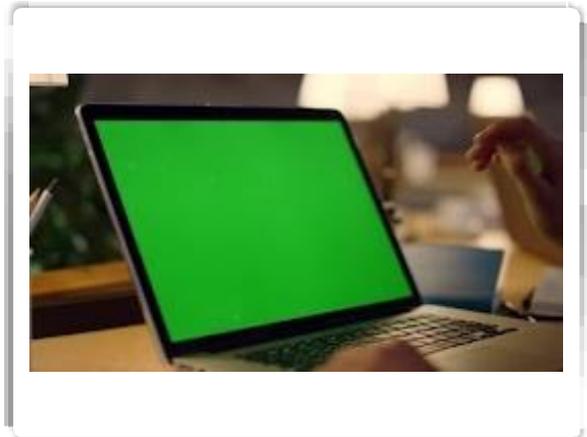
○ I don't know

○ Other: _____

43. Approximately, how long have you been using a computer (in years)? *

_____

44. On average, how many hours a day do you spend using a computer? *

_____

Regarding your use of computers

Now we want to know what your opinion is about the interfaces of the programs, applications an websites you use on your computer.
Remember, the interface is the environment for interaction between the user and an operating system, which represents programs, files and options through icons, menus or dialog boxes.

In general, and regarding the interfaces you usually interact with, from 1 to 5 indicate...

45.   What do you think of the text size? *

Mark only one oval.

	1	2	3	4	5	
Nothing adequate	○	○	○	○	○	Totally adequate

46.   What do you think of the size of the images? *

Mark only one oval.

	1	2	3	4	5	
Nothing adequate	○	○	○	○	○	Totally adequate

47.   What do you think of the size of buttons and other interactive elements? *

Mark only one oval.

	1	2	3	4	5	
Nothing adequate	○	○	○	○	○	Totally adequate

48. What do you think of the contrast between colors? *

Mark only one oval.

	1	2	3	4	5	
Nothing adequate	◯	◯	◯	◯	◯	Totally adequate

Still about the programs or websites you usually use, indicate how often you encounter the following situations. Being 1, never and 5, always.

49. How often do you find disorganized or confusing menus? *

Mark only one oval.

	1	2	3	4	5	
Never	◯	◯	◯	◯	◯	Always

50. How often do you find interfaces with more information than you need? *

Mark only one oval.

	1	2	3	4	5	
Never	◯	◯	◯	◯	◯	Always

51. How often do you find interfaces with more features than need? *

Mark only one oval.

	1	2	3	4	5	
Never	◯	◯	◯	◯	◯	Always

52. How often do you find interfaces that are not adapted to your needs or interests? *

Mark only one oval.

	1	2	3	4	5	
Never	◯	◯	◯	◯	◯	Always

53. Do you want to comment?

_____

_____

_____

_____

_____

Thinking now of ways to adapt the interface to your needs and interests, from 1 to 5 indicate...

54. How important would it be for you to have control over the design/layout of program, website or application interfaces?

For example, control sizes, fonts, colors or elements order.

Mark only one oval.

	1	2	3	4	5	
Nothing important	◯	◯	◯	◯	◯	Very important

55. How important would it be for you to have control over the features or behavior of applications, programs or websites?

For example, change existing features or add new ones.

Mark only one oval.

	1	2	3	4	5	
Nothing important	○	○	○	○	○	Very important

56. How important is it for you to pay attention to this study? Please tick 5. *

Mark only one oval.

	1	2	3	4	5	
Nothing important	○	○	○	○	○	Very important

57. Can you give examples of changes you would like to make?

Try to think about how you would adapt an interface to achieve a better user experience. Think abo interaction problems you may have and how to fix them.

_____

_____

_____

_____

_____

Regarding how you personalize computer interfaces

Personalize means to make something suitable for our needs and preferences.

Computer software offers some options for personalizing the interface. For example, you can change the position of the taskbar, text size or font type. In this section we want to know more about how you adapt the interfaces to your personal liking.
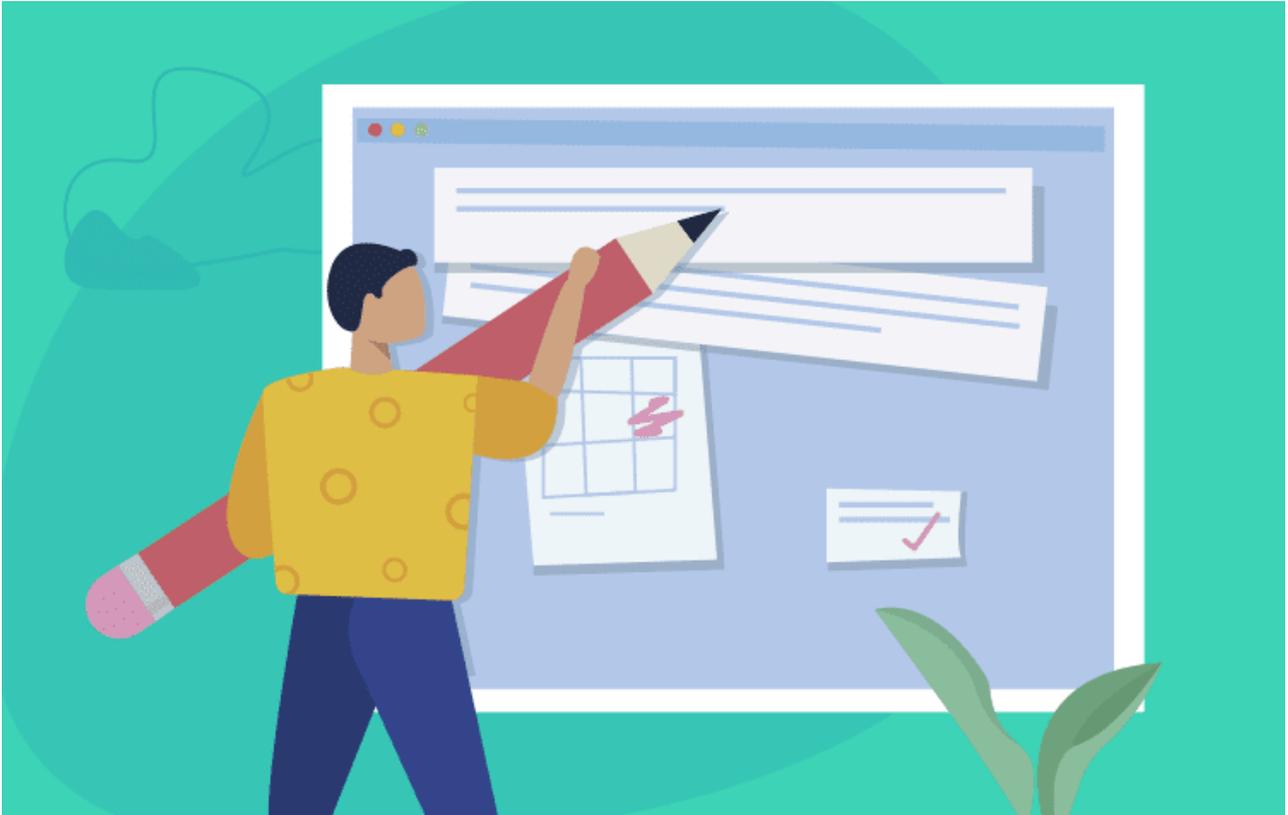
Regarding how you adapt the computer (whether the system, websites or programs) to your personal liking.

58. Have you ever changed the layout of icons in the start menu, taskbar or dock? *
    You can add, sort or remove icons.

    Mark only one oval.

    ⬭ Yes

    ⬭ No

    ⬭ I didn't know it was possibleI

    ⬭ don't know how to answer

59. Have you ever changed your desktop's background image? *

You can change the image that appears in the background of your desktop.

Mark only one oval.

○ Yes

○ No

○ I didn't know it was possibleI

○ don't know how to answer

60. Have you ever changed the text size or font type? *

Through the settings it is possible to make the text larger or smaller or change the font.

Mark only one oval.

○ Yes

○ No

○ I didn't know it was possibleI

○ don't know how to answer

61. Have you ever changed the system colors? *

For example, choose the hue of the taskbar/dock.

Mark only one oval.

○ Yes

○ No

○ I didn't know it was possibleI

○ don't know how to answer

62. Have you ever changed the theme of a program or website? *

For example, some programs/websites allow you to switch from a lighter theme to a darker (mainly affecting the colors) , and vice versa.

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ I didn't know it was possiblel
- ◯ don't know how to answer

In addition to the changes described above, there are other specific programs that allow for deeper personalizations. For example, creating keyboard shortcuts or changing icons.
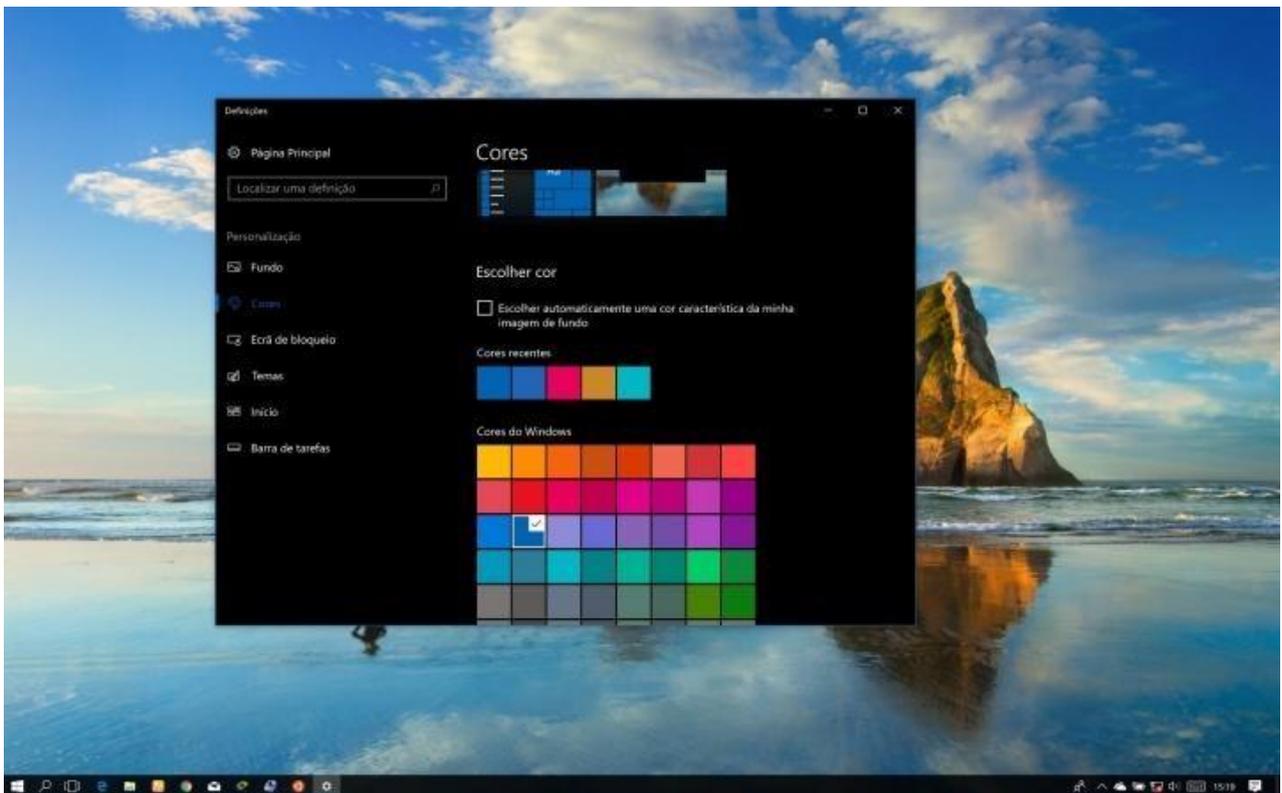
63. Have you ever searched for programs or tools that would allow you to somehow adapt the device?

For example, an application that enlarges the screen or adjusts color contrast.

Mark only one oval.

◯ Yes

◯ No

◯ I don't know

64. Do you have any such tools or programs, that personalize your computer, installed? If not, why? Have you tried one? If so, which and why?

For example, applications that change the font characteristics.

_____

_____

_____

_____

_____

Regarding the web browser you use.
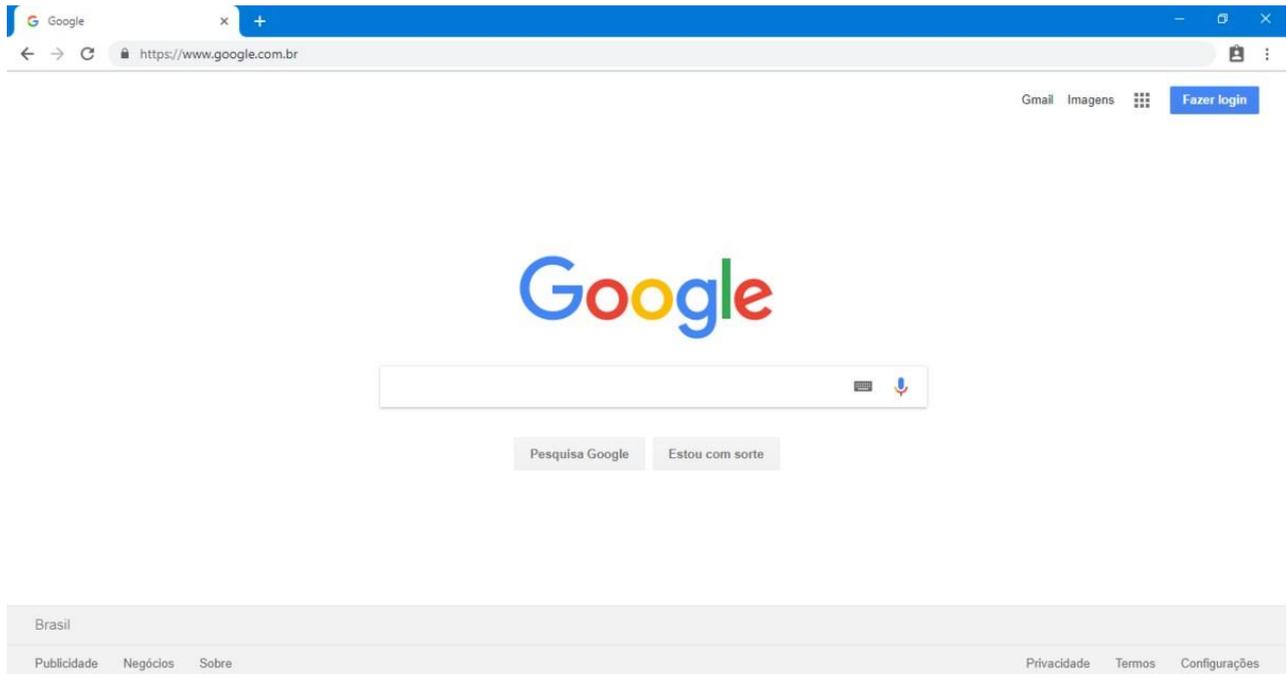
65.   Are you familiar with the concept of browser extensions? *
        Google Chrome example: https://chrome.google.com/webstore/category/extensions?hl=en

Mark only one oval.

( ) Yes

( ) No

66.   Do you use any ad blocking tool? *
        For example, adblocker.

Mark only one oval.

( ) Yes

( ) No

( ) I didn't know it was possible

67.   Do you use any other browser extension that changes a web page (for example that changes the text format)? If yes, which one? If not, why?

_____

_____

_____

_____

_____

Some scenarios to reflect on

Before finishing, we'd like to know your opinion about different personalization scenarios.

We're going to introduce you to three different personalization scenarios. We will ask you questions about each of them and try to figure out your opinion.
Personalize means to make something suitable for our needs and preferences.

Scenario 1. Imagine that each website or application has an interface personalization tool available. When you access it, you can adjust the style of all displayed elements: colors, font, menu shortcuts, order and placement of elements on the screen, etc. From there, you get a unique version of the interface designed by you and for you. You always access this version, and you can make adjustments at any time.
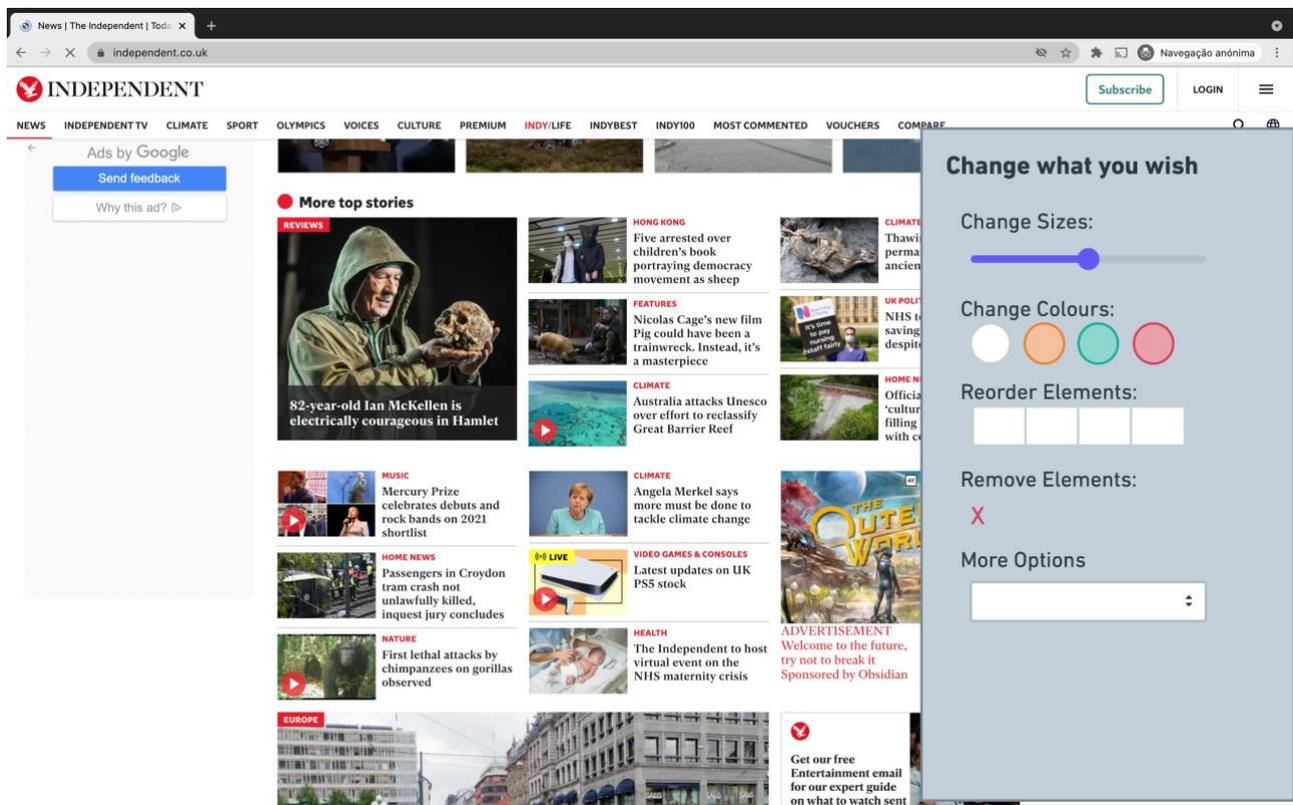
68.   How beneficial would scenario 1 be for you? *

Mark only one oval.

	1	2	3	4	5	
Nothing beneficial	◯	◯	◯	◯	◯	Very beneficial

69. How beneficial would it be for you to be able to share personalizations you made or use personalizations created by others?

For example, change the interface to your liking and share it with a friend.

Mark only one oval.

	1	2	3	4	5	
Nothing beneficial	◯	◯	◯	◯	◯	Very beneficial

70. Which of these factors would make you adopt the system described in scenario 1? *

Tick all that apply.

☐ Difficulties in accessing or viewing a content (accessibility)
☐ Invitation from a friend or family member (social influence)
☐ Not being satisfied with the design of the site/application (satisfaction)
☐ Try to be more efficient in using the site/application (efficiency)
☐ The pleasure of controlling the interface and what I see (sense of control)
☐ Create an interface that reflects who I am (sense of identity)
☐ Tiredness of the original interface / Willingness to interact with something different
☐ Curiosity
☐ Fun
☐ None of these (use the "Other option" if you wish to specify)
☐ Other: _____

71. Which of these factors would make you NOT want to adopt the system described in scenario 1?

Tick all that apply.

- [ ] Lack of interest
- [ ] Lack of time
- [ ] I can't see utility
- [ ] Too complex
- [ ] Be satisfied with the original version of the website/application interface
- [ ] Be used to the original version of the website/application
- [ ] Fears related to privacy and data security
- [ ] Lack of programming skills
- [ ] Lack of design skills
- [ ] Trust that developers/designers know what works best for me
- [ ] Difficulties in imagining a version of the interface other than the original
- [ ] None of these (use the "Other option" if you wish to specify)
- [ ] Other: _____

72. Who do you think would benefit most from scenario 1? *

Tick all that apply.

- [ ] Seniors
- [ ] Kids
- [ ] People with some kind of disability
- [ ] People in general, with or without any type of disability
- [ ] None
- [ ] Other: _____

73. Do you want to comment on scenario 1?

_____

_____

_____

_____

_____

Scenario 2. Imagine that each website or application has different versions of its interface available. In each version, everything can change: the colors, the font, the menu, the order and positioning of the elements on the screen, etc. When visiting a website or application, you can choose which version you would like to use and from there always access that version (you can revert your decision at any time).
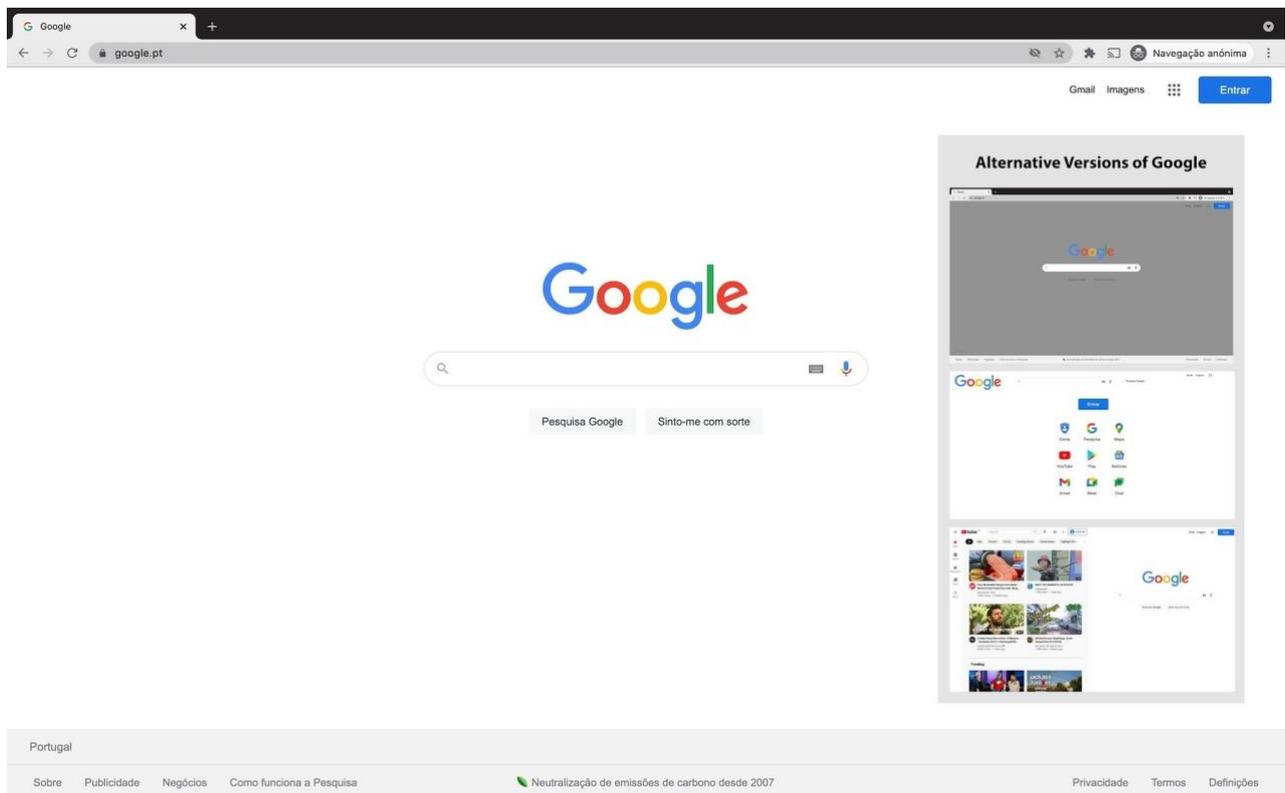
74. How beneficial would scenario 2 be for you? *

Mark only one oval.

	1	2	3	4	5	
Nothing beneficial	◯	◯	◯	◯	◯	Very beneficial

75. Which of these factors would make you adopt the system described in scenario 2? *

Tick all that apply.

- ☐ Difficulties in accessing or viewing a content (accessibility)
- ☐ Invitation from a friend or family member (social influence)
- ☐ Not being satisfied with the design of the site/application (satisfaction)
- ☐ Try to be more efficient in using the site/application (efficiency)
- ☐ The pleasure of controlling the interface and what I see (sense of control)
- ☐ Create an interface that reflects who I am (sense of identity)
- ☐ Tiredness of the original interface / Willingness to interact with something different
- ☐ Curiosity
- ☐ Fun
- ☐ None of these (use the "Other option" if you wish to specify)
- ☐ Other: _____

76. Which of these factors would make you NOT want to adopt the system described in scenario 2?

Tick all that apply.

- ☐ Lack of interest
- ☐ Lack of time
- ☐ I can't see utility
- ☐ Too complex
- ☐ Be satisfied with the original version of the website/application interface
- ☐ Be used to the original version of the website/application
- ☐ Fears related to privacy and data security
- ☐ Lack of programming skills
- ☐ Lack of design skills
- ☐ Trust that developers/designers know what works best for me
- ☐ Difficulties in imagining a version of the interface other than the original
- ☐ None of these (use the "Other option" if you wish to specify)
- ☐ Other: _____

77. Who do you think would benefit most from scenario 2? *

Tick all that apply.

- ☐ Seniors
- ☐ Kids
- ☐ People with some kind of disability
- ☐ People in general, with or without any type of disability
- ☐ None
- ☐ Other: _____

78. Do you want to comment on scenario 2?

_____

_____

_____

_____

_____

Scenario 3. Imagine that there is a system that automatically perceives your characteristics (for example, it can understand which features you use more often or what difficulties you have interacting with an interface). When the system detects that an interface could be improved, it makes suggestions for small changes that it could make (for example, suggest increasing the font size and buttons size, or reordering the menu options). These changes would be automatically applied after authorization.
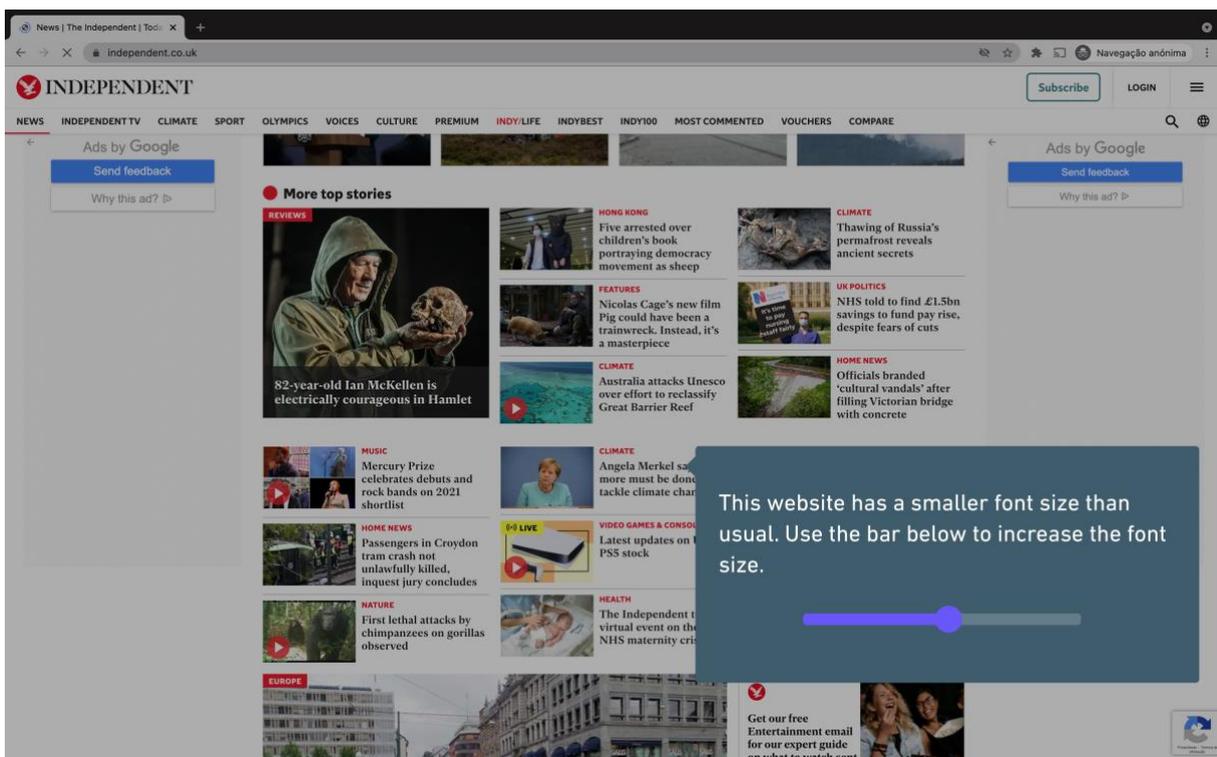
79. How beneficial would scenario 3 be for you? *

Mark only one oval.

	1	2	3	4	5	
Nothing beneficial	◯	◯	◯	◯	◯	Very beneficial

80. How beneficial would it be for you if the system were able to apply the changes automatically (without making suggestions)?

Mark only one oval.

	1	2	3	4	5	
Nothing beneficial	◯	◯	◯	◯	◯	Very beneficial

81. How beneficial would it be for you if the system were also able to understand the context in which you are using your device?

Context includes knowing for example the weather, your location, or people you are with. For example, imagine if the system is able to notice that you are walking while using your device and makes suggestions for interface changes, or if it notices that you are at work and that you may not want to see some elements or images on the interface.

Mark only one oval.

	1	2	3	4	5	
Nothing beneficial	◯	◯	◯	◯	◯	Very beneficial

82. Which of these factors would make you adopt the system described in scenario 3? *

Tick all that apply.

- [ ] Difficulties in accessing or viewing a content (accessibility)
- [ ] Invitation from a friend or family member (social influence)
- [ ] Not being satisfied with the design of the site/application (satisfaction)
- [ ] Try to be more efficient in using the site/application (efficiency)
- [ ] The pleasure of controlling the interface and what I see (sense of control)
- [ ] Create an interface that reflects who I am (sense of identity)
- [ ] Tiredness of the original interface / Willingness to interact with something different
- [ ] Curiosity
- [ ] Fun
- [ ] None of these (use the "Other option" if you wish to specify)
- [ ] Other: _____

83. Which of these factors would make you NOT want to adopt the system described in scenario 3?

Tick all that apply.

- [ ] Lack of interest
- [ ] Lack of time
- [ ] I can't see utility
- [ ] Too complex
- [ ] Be satisfied with the original version of the website/application interface
- [ ] Be used to the original version of the website/application
- [ ] Fears related to privacy and data security
- [ ] Lack of programming skills
- [ ] Lack of design skills
- [ ] Trust that developers/designers know what works best for me
- [ ] Difficulties in imagining a version of the interface other than the original
- [ ] None of these (use the "Other option" if you wish to specify)
- [ ] Other: _____

84. Who do you think would benefit most from scenario 3? *

Tick all that apply.

- ☐ Seniors
- ☐ Kids
- ☐ People with some kind of disability
- ☐ People in general, with or without any type of disability
- ☐ None

☐ Other: _____

85. Do you want to comment on scenario 3?

_____

_____

_____

_____

_____

About the personalization of interfaces (in general)

86. Want to comment on the interface personalization concept? Would you like to propose another scenario?

_____

_____

_____

_____

_____

Skip to section 16 (Thank you!)

Do not consent

As you do not wish to participate in this study, please return your submission on prolific by selecting the 'Stop without completing' button.

Unable to participate

You are ineligible for this study, as you need to be a user of mobile devices and personal computers to participate. Please return your submission on Prolific by selecting the 'Stop without completing' button.

Thank you!

Please complete the following two steps to record your survey response and receive your reward:

1) Visit this Completion URL to complete your submission on Prolific:
https://app.prolific.co/submissions/complete?cc=X

2) Click 'Submit' on this page to record your response.

If you do not complete the second step, we will not receive your data and will be unable to reward you.

Appendix C

Study 3

C.1   Think-Aloud Interview Script

Initial Interview Script & Recommendations

1. Start by introducing yourself and thanking participants in the study:
   a. "Good afternoon. Thank you once again for participating in this study. Today's meeting aims to explain how the study will work and to do some personalization tasks. This session is expected to last one hour. You are free to withdraw at any time. If you need a break, feel free to let me know.";
   b. "Let's start by gathering some personal information about how you perceive and use technology. Then, we will ask you to complete a task using our tool. Finally, you will answer a short questionnaire to evaluate the tool."
2. Collect the informed consent and present the information sheet.
3. Fill in the CRF, the computer self-efficacy scale, and the IPIP-NEO.
4. Perform a 30-minute think-aloud personalization session:
   a. "Can I start recording the audio and screen?"
   b. "Now, let's move on to the most interesting part. We developed a tool, a Chrome extension, that allows you to personalize any website. You can change colors and fonts, hide elements, and move things around. As you can see, we have all these options available [show the tool]."
   c. "Here, we have an image that showcases what our tool is capable of. We would like you to use it to help us gather feedback on the tool. Your task will be to make the changes highlighted in the image so that the website matches it. Don't worry; we'll be here to assist you. Since we'll be recording, and we want to understand any difficulties you encounter and identify weaknesses in our tool, we ask that you verbalize your thoughts as you go. For example: [looks at the screen] 'Okay, here's a button labeled "color," it's probably for changing the color. I'll click it and see what happens. All right, that did something; now I'll change the color of this text.
   d. "Any questions? Let's go ahead and get started."
   e. Tips:
      i. Don't ask questions that the participants have already answered;
      ii. When the answers are not satisfactory in detail, find alternative questions to find information;
      iii. Make the participants talk, not you.
      iv. Don't be afraid of silence. Silences are good; they make the participants think and delve deeper. Don't rush.
5. Explain how the requests work:
   a. "As you may have noticed, another option here is 'requests.' This allows you to ask someone else for help when you don't want to or can't personalize something. The person will receive your request, and you'll be notified once they've made the changes you asked for."
   b. "It also works the other way around. When someone else needs help, you will receive an email and a notification with their request."

    c. "It is essential that you understand how the tool works today. Do you have any questions?"

6. Thank the participants and invite them to use the extension:

    a. "Now, let me explain the next task of the study. Over the next 2 weeks, we will ask you to use the tool. We will send you an email with the link and details on installing the tool. You should use the tool on at least three websites. You can personalize them for yourself or make a help request. Apart from that, feel free to use the tool as you like. You can use the tool whenever you want to change something on a website. Or, if you're able to, you can try helping others by responding to their personalization requests."

    b. "During this period, imagine that you are a designer. There is only one rule: there are no rules! I want you to think that any change is possible. Please forget any preconceived notions you have about websites (e.g., the menu doesn't always have to be at the top of the screen) and embrace the mindset of a true designer. If you're personalizing for yourself, the final result doesn't need to work well for others but rather for you. If you can't do what you want or don't have time, feel free to ask for help."

    c. "Once again, thank you very much for accepting to participate."

C.2 Results of the NEO-FFI-20

Table C.1: Participants' big five personality traits (mean). Results from the NEO-FFI-20 questionnaire.

ID	Neuroticism	Extraversion	Openness	Agreeableness	Conscientiousness
P1	2.75	2.75	2.5	3	2.75
P2	0	1	1	2	3
P3	1.25	1.75	1.75	1.5	2.75
P4	2.75	2.75	2.25	1.75	3.25
P5	2.75	1.75	1.75	2.50	3.25
P6	2.5	2.5	2.75	2	3.75
P7	2.5	2	2.25	1.5	2.75
P8	2.5	2	1.5	1.5	3.25
P9	2.25	1.25	1.75	1.25	3.5

C.3 Final Interview Script

Final Interview script & Recommendations

Before the session:

1. Print the requests received by that person and check how many and what personalizations she/he did.

During the session:

1. Start by thanking participants in the study:
   a. "Good afternoon. Thank you once again for participating in this study. The goal of today's meeting is to review what was done during the study. This session is expected to last one hour. You are free to withdraw at any time. If you need a break, feel free to let me know.";
2. Hand the voucher
3. Start recording the audio
   a. "Can I start recording the audio?"
4. Interview Questions:
   a. "Let's now talk about your experience with the tool.
      i. How did the experience go?
      ii. Did you find any positive aspects or benefits?
      iii. What were the biggest challenges?
      iv. In what situations did you use the tool?
      v. Was it at any specific moment?
      vi. For what purpose?
      vii. Did you try to use it whenever you had an issue with the original interface?
      viii. In what situations did you ask for help? Why didn't you ask for help?
      ix. Would you use a tool like this if you had access to it? Why? Are you interested in personalization?
      x. Do you see potential for applying personalization in other contexts? Or for making other types of customizations?
      xi. What is missing from the tool?"
   b. About personalizing for others:
      i. What factors did you consider when personalizing for others?
      ii. Do you think that being aware of the data about the requester changed anything?
      iii. What were the challenges of personalizing for others?
      iv. What is the best time to receive requests?
      v. How important is receiving feedback?
      vi. How could we motivate you to personalize for others (gamification, rewards, gratitude, recognition), and in what situations would you do it?
5. Thank the participants:
   a. "Thank you again for participating in this study."

Tips:

1. Use the requests the participant received and compare their performance during the study with their perspectives before the study and with the IPIP-NEO results and the self-efficacy scale.
2. Don't ask questions that the participants have already answered;
3. When the answers are not satisfactory in detail, find alternative questions to find information;
4. Make the participants talk, not you.
5. Don't be afraid of silence. Silences are good; they make the participants think and delve deeper. Don't rush.

Appendix D

Study 4

D.1   Interview Script

Interview Script

1. Start by introducing yourself and thanking the participant:
   a. "Hello. Thank you again for participating in this study. This session is expected to last 1 hour and 30 minutes. At any time, you are free to withdraw. If you need a break, feel free to let me know.";
2. Present the information sheet and collect the informed consent.
3. Perform the interview:
   a. "Now, let us move on to the most interesting part. Here, we have a set of vignettes that tell the story of Alex and Chris. I want to ask you to think like them. Let us read the characters' stories and try to reflect on some topics related to visualizing UI interaction data. There are four sets of vignettes (42 in total), with the last one in each set containing some questions we will address here."
   b. "Any question? Let us get started then."
   c. "I will start recording the audio, ok?"
   d. "Let's start reading the vignettes. The firsts explain who Alex and Chris are. Do you want me to read it?"
   e. Show other materials: "These images show the original version of the UIs we will see today. I will put them on the table for reference."
   f. About **Vignettes A**:
      i. "These vignettes show part of the data that was collected for Alex and Chris. There are different types of data and different ways to view it. I ask you to carefully analyze each of the images and express what you are thinking. Then, we will try to answer the questions from the last vignettes."
      ii. **Introduce personalization tool:** "These improvements could be implemented with a personalization tool like the one we see here in this image [hand exemplificative image to participant and explain]."
   g. About **Vignettes B**:
      i. "These vignettes show a version of the system where, in addition to viewing the data, users also have access to improvement suggestions they could make to the interface."
   h. About **Vignettes C**:
      i. "In these vignettes, Alex and Chris have access to visual suggestions with a personalized version of the interface (according to their data), and they just need to confirm if they accept the suggestions."
   i. About **Vignettes D**:
      i. "In these vignettes, user data is used anonymously to improve the system experience. For example, users have access to a series of changes implemented by other users that may benefit them as well."
   j. Tips:

Interview Script

        a. Don't ask questions that have already been answered by the participants;

        b. When the answers are not satisfactory in detail, find alternative questions to find information;

        c. Make the participants talk, not you.

        d. Don't be afraid of silence. Silences are good; they make the participants think and delve deeper. Don't rush.

ii. Thank the participant and hand over the **voucher**:

    1. "Once again, thank you very much for agreeing to participate. Here is your voucher as a thank you for participating in our study."

D.2 Base Vignettes

About Alex

Alex, aged 32 and a graduate since 2014, is currently employed in a multinational consultancy. Engaged with digital devices daily, Alex utilizes the computer for work and relies on the smartphone for various tasks. Recently, Alex has developed a growing interest in comprehending how application interactions unfold. To address this curiosity, Alex installed UIPulse, which provides insights into application usage. Data is stored locally, with exclusive access to Alex.

About Chris

Chris

Chris, aged 59, currently works as a cashier in a supermarket. Chris started using digital devices less than five years ago. Despite not using them often, Chris likes to visit some websites and applications of interest at the end of the day. Last week, Chris discovered that the devices Chris uses (smartphone and computer) have been collecting information about the interaction with applications and websites. In light of this, Chris decided to access this information for the first time.

Home (Week of 3 July)

Alex's Smartphone

Diary Usage: 4h 37 min
↓ 12% last week

Top Daily Applications (average in minutes)

- Netflix 60m
- Instagram 45m
- Tikok 37m
- Facebook 30m
- YouTube 23m
- WhatsApp 10m
- Email 8m
- Outros 64m

2 | Alex's Computer

Diary Usage: 4h 20 min
↑ 20% last week

Top Daily Applications (average in minutes)

- Google Chrome 120m
- Candy Crush Soda Saga 43m
- Microsoft Word 20m
- Microsoft PowerPoint 7m
- Email 7m
- Discord 5m
- Outros 58m

Top Daily Websites (average in minutes)

- facebook.com 28m
- twitter.com 25m
- publico.pt 22m
- record.pt 13m
- lidl.pt 4m
- continente.pt 3m
- Outros 25m

A3

Home (Week of 3 July)

Chris

1 | Chris's Smartphone

Diary Usage: 2h 30 min
↓ 4% last week

Top Daily Applications (average in minutes)

- Google 40m
- Instagram 20m
- Olx 18m
- Facebook 15m
- YouTube 10m
- WhatsApp 10m
- Email 8m
- Outros 29m

2 | Chris's Computer

Diary Usage: 1h 15 min
↑ 4% last week

Top Daily Applications (average in minutes)

- Google Chrome 36m
- Candy Crush Soda Saga 15m
- Microsoft Word 4m
- Paint 4m
- Email 7m
- Zoom 3m
- Outros 6m

Top Daily Websites (average in minutes)

- facebook.com 10m
- olx.com 8m
- publico.pt 5m
- linkedin.com 4m
- lidl.pt 4m
- continente.pt 3m
- Outros 2m

A4

Lidl – Global Data (Week of 3 July)

Last week visits

Last week summary of visits

Page	Visits	Number of Visits per Session	Average Time on Page	Average Number of Clicks	Average Number of Missed Clicks	% Failed Searches
https://www.lidl.com	12	1,7	20s	5	1	20%
https://www.lidl.com/specials	2	0,3	1m20s	15	3	0%
https://www.lidl.com/leaflets	8	1,1	4m	26	8	0%
https://www.lidl.com/news	1	0,1	59s	1	0	0%

Lidl – Global Data (Week of 3 July)

Frequent tasks

Task	Frequency	Average Task Time
lidl.com > lidl.com/leaflets	8	1.3s
lidl.com > lidl.com/specials	2	1s

Lidl – Heatmap

Number of mouse clicks (from blue to red).

Lidl – Heatmap

Frequency of vertical scrolling for certain areas of the screen (from blue to red).
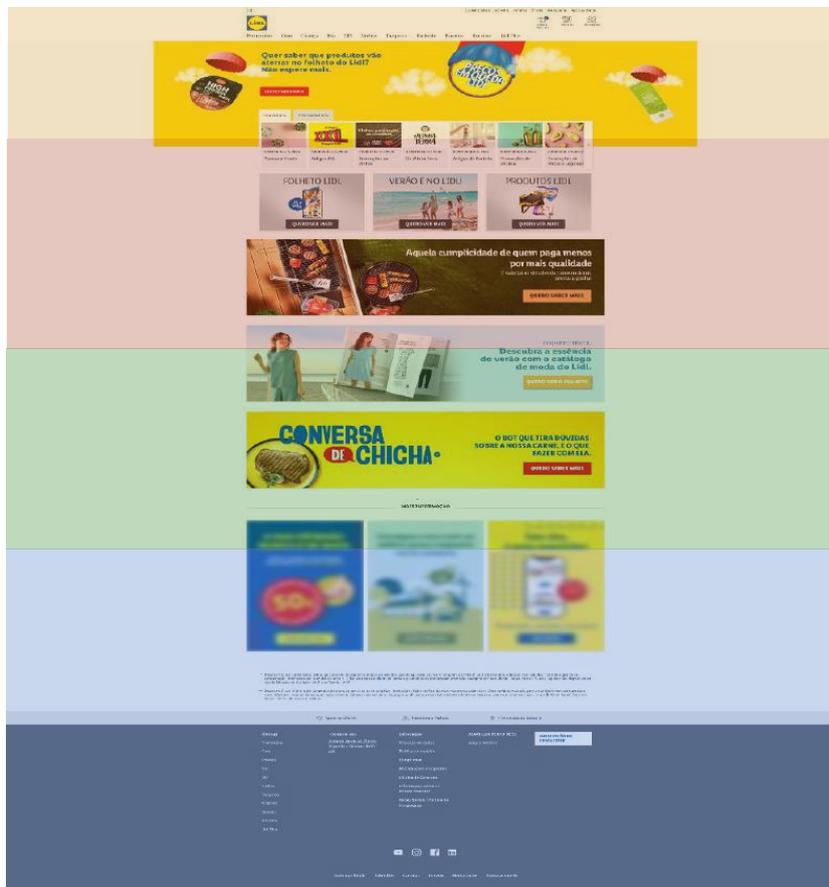
Lidl/leaflets – Heatmap
Number of mouse clicks (from blue to red).
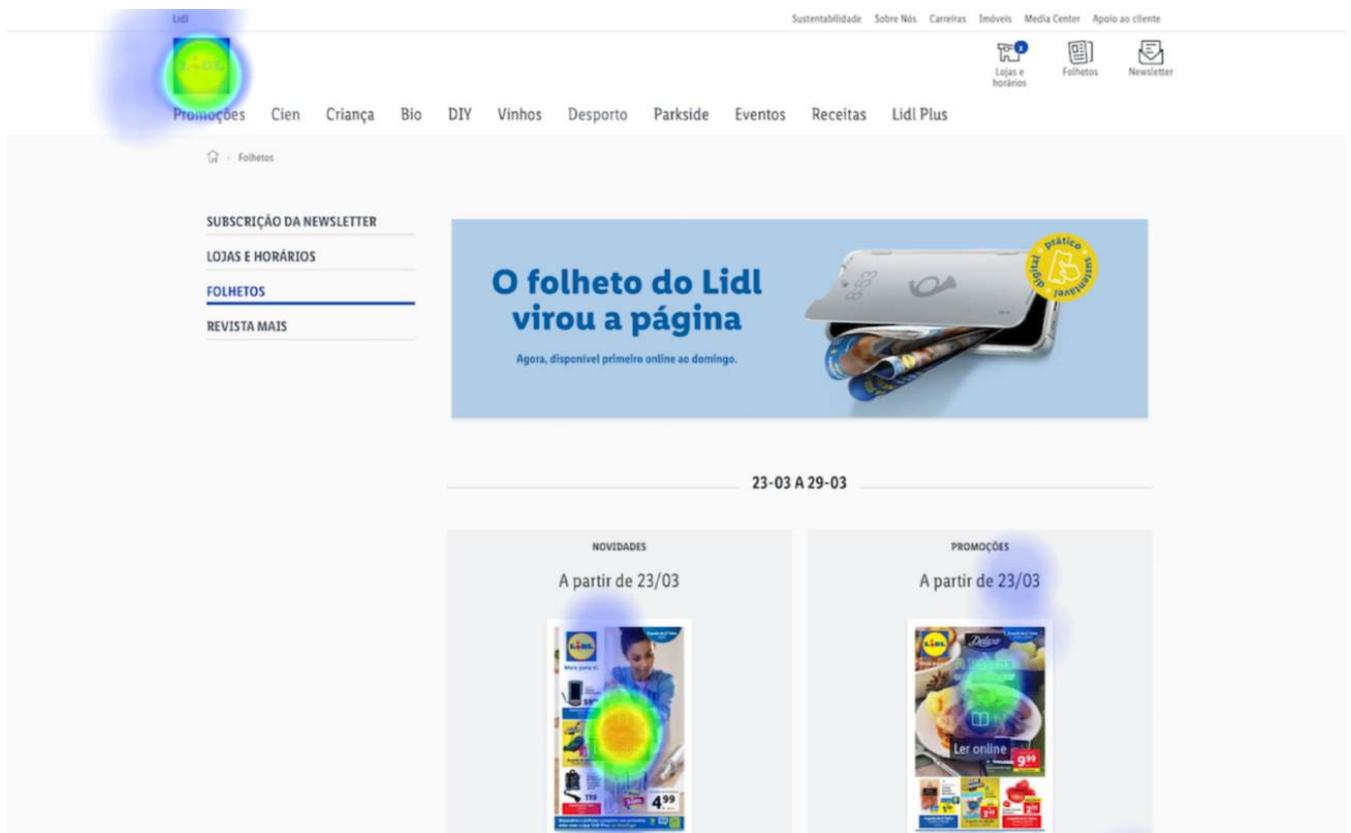
Questions

Alex

Please answer the following questions:

1. Why do you think Alex has been more concerned about interactions with his/her applications and started to observe his/her behaviour? What do you think could have motivated this?

2. How do you think Alex will react to the presented data? What do you imagine Alex will do with the data?

3. How will Alex feel about the security and privacy of his/her data?
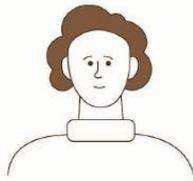
Questions

Chris

Please answer the following questions:

1. Why do you think Chris has been more concerned about interactions with his/her applications and started to observe his/her behaviour? What do you think could have motivated this?

2. How do you think Chris will react to the presented data? What do you imagine Chris will do with the data?

3. How will Chris feel about the security and privacy of his/her data?

Questions

Please answer the following questions about yourself:

1. Are you familiar with the website lidl.pt?

2. Have you ever worried about your interactions with apps or been interested/curious in observing your habits? Why?

3. What use do you see in this type of data? How do you think you would use the data?

4. How would you feel about the security and privacy of your data?

Example of a Customization Tool (CrowdAdapt)

Questions

Alex

Please answer the following questions:

1. Which vignette might be more interesting for Alex to analyze?
2. What type of data/visualizations could Alex be missing?
3. How do you think Alex can improve his/her interactions?
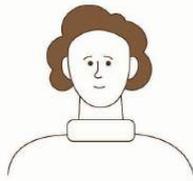
Questions

Chris

Please answer the following questions:

1. Which vignette might be more interesting for Chris to analyze?
2. What type of data/visualizations could Chris be missing?
3. How do you think Chris can improve his/her interactions?

Questions

How likely is Alex to personalize?

1   2   3   4   5

Not likely   Very likely

How likely is Chris to personalize?

1   2   3   4   5

Not likely   Very likely

Questions

Mark how beneficial it would be for you to have access to this data and how costly it would be to analyze and use it to personalize.

Benefit

| 1 | 2 | 3 | 4 | 5 |

Nothing beneficial   Very beneficial

Cost

| 1 | 2 | 3 | 4 | 5 |

Nothing costly   Very costly

Lidl – Textual Suggestions

Based on your usage, we identified the following improvements.

Most used item. Suggestion: Place in a better position.

Page too slow to load. Suggestion: Hide images.

Lidl – Textual Suggestions

Based on your usage, we identified the following improvements. We estimate that this personalization would require approximately four minutes, yielding a benefit of three seconds per visit.

Most used item. Suggestion: Place in a better position.

Page too slow to load. Suggestion: Hide images.

Questions

Alex

Please answer the following questions:

1. How do you think Alex will react to these suggestions?

2. Compared to the previous set of vignettes, will the way Alex interprets the data change?

3. What advantages and disadvantages will Alex see in this approach?

How likely is Alex to personalize?

1	2	3	4	5
Not likely			Very likely	

Questions

Chris

Please answer the following questions:

1. How do you think Chris will react to these suggestions?

2. Compared to the previous set of vignettes, will the way Chris interprets the data change?

3. What advantages and disadvantages will Chris see in this approach?

How likely is Chris to personalize?

1	2	3	4	5
Not likely			Very likely	

Questions

Mark how beneficial it would be for you to have access to this data and how costly it would be to analyze and use it to personalize.

Benefit

1	2	3	4	5

Nothing beneficial   Very beneficial

Cost

1	2	3	4	5

Nothing costly   Very costly

Lidl – Visual Suggestions

Based on your usage, we propose the following changes.

Lidl – Visual Suggestions

Based on your usage, we propose the following changes.

Questions

Alex

Please answer the following questions:

1. How do you think Alex will react to these suggestions?

2. Compared to the previous set of vignettes, will the way Alex interprets the data change?

3. What advantages and disadvantages will Alex see in this approach?

How likely is Alex to personalize?

1   2   3   4   5

Not likely   Very likely

C33

Questions

Chris

Please answer the following questions:

1. How do you think Chris will react to these suggestions?

2. Compared to the previous set of vignettes, will the way Chris interprets the data change?

3. What advantages and disadvantages will Chris see in this approach?

How likely is Chris to personalize?

1	2	3	4	5
Not likely			Very likely	

C34

Questions

Mark how beneficial it would be for you to have access to this data and how costly it would be to analyze and use it to personalize.

Benefit

| 1 | 2 | 3 | 4 | 5 |

Nothing beneficial   Very beneficial

Cost

| 1 | 2 | 3 | 4 | 5 |

Nothing costly   Very costly

Lidl – Social Suggestions

Based on what other people like.

20% of our users use mostly the shortcut "Leaflets". 13% of users are using the following version of Lidl. Click to import this version. `Confirm`

Lidl/specials – Social Suggestions

Based on what other people like.

30% of our users are unhappy with the design. Click to import the following alternative.

Confirm

Questions

Alex

Please answer the following questions:

1. How do you think Alex will react to these social suggestions?

2. What advantages and disadvantages will Alex see in this approach?

3. How will Alex feel about the security and privacy of his/her data?

4. Should Alex also anonymously allow using his/her data to improve the software's suggestions?

5. Overall, do you think this data is enough for Alex to personalize?

How likely is Alex to personalize?
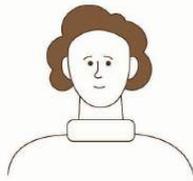
1	2	3	4	5
Not likely			Very likely	

Questions

Chris

Please answer the following questions:

1. How do you think Chris will react to these social suggestions?

2. What advantages and disadvantages will Chris see in this approach?

3. How will Chris feel about the security and privacy of his/her data?

4. Should Chris also anonymously allow using his/her data to improve the software's suggestions?

5. Overall, do you think this data is enough for Chris to personalize?

How likely is Chris to personalize?

1   2   3   4   5

Not likely   Very likely

D41

Questions

Please answer the following questions about yourself:

1. Can you think of specific cases where it makes sense to share your data?
2. What use do you see in this type of data? How do you think you would use the data?
3. How would you feel about the security and privacy of your data?
4. How could this data be integrated into a personalization tool?

Mark how beneficial it would be for you to have access to this data and how costly it would be to analyze and use it to personalize.

Benefit

1   2   3   4   5

Nothing beneficial   Very beneficial

Cost

1   2   3   4   5

Nothing costly   Very costly

D42

Other Materials

Lojas e horários   Folhetos   Newsletter

Promoções   Cien   Criança   Bio   DIY   Vinhos   Desporto   Parkside   Eventos   Receitas   Lidl Plus

Este ano há tachos para todos

De 9 de março a 5 de abril,
habilite-se a um tacho de 1.000€/mês durante 1 ano.

Quero saber mais

tacho Lidl

| Esta semana | Próxima semana |

Favorina acabou de chegar!

Deluxe — Prepare-se para receber a Páscoa

A PARTIR DE 5.ª F, 23.02
Favorina

A PARTIR DE 5.ª F, 02.03
Deluxe

A PARTIR DE 2.ª F, 20.03
Trabalhos Criativos

A PARTIR DE 2.ª F, 20.03
Promoções de Carne

A PARTIR DE 2.ª F, 20.03
Promoções de Peixe

A PARTIR DE 2.ª F, 20.03
Promoções de Frutas e Legumes

A PARTIR DE 2.ª F, 20.03
Promoções de Frescos

FOLHETO LIDL
JÁ À MÃO

PRODUTOS LIDL

PASSATEMPOS E CONCURSOS

Lojas e horários   Folhetos   Newsletter

Promoções   Cien   Criança   Bio   DIY   Vinhos   Desporto   Parkside   Eventos   Receitas   Lidl Plus

⌂ › Folhetos

SUBSCRIÇÃO DA NEWSLETTER

LOJAS E HORÁRIOS

FOLHETOS

REVISTA MAIS

O folheto do Lidl virou a página

Agora, disponível primeiro online ao domingo.

digital · prático · sustentável

23-03 A 29-03

NOVIDADES	PROMOÇÕES
A partir de 23/03	A partir de 23/03

Ler online

Ler online

LIDL

Lojas e horários   Folhetos   Newsletter

Promoções   Cien   Criança   Bio   Vinhos   DIY   Desporto   Parkside   Eventos   Receitas   Lidl Plus

Esta semana   Próxima semana

A PARTIR DE 2.ªF, 29.05	A PARTIR DE 2.ªF, 29.05	A PARTIR DE 2.ªF, 29.05	A PARTIR DE 2.ªF, 29.05	A PARTIR DE 2.ªF, 29.05	A PARTIR DE 5.ªF, 01.06	A PARTIR DE 5.ªF, 01.06
Promoções de Peixe	Promoções de Frescos	Promoções de Carne	Promoções de Higiene e Limpeza	Promoções de Frutas e Legumes	Artigos de Verão	Plantas e Flores

A PARTIR DE 2.ª FEIRA

29.05. - 31.05.

Ocean Sea® Pescada do Cabo em Postas Grandes

5.33 *

Emb. 800 g | 1 kg = 6.67

29.05. - 31.05.

Três Velas® Bacalhau Posta Tradicional

8.48 *

Emb. 800 g | 1 kg = 10.60

29.05. - 31.05.

Ocean Sea® Caldeirada de Peixe

4.49 *

Emb. 700 g | 1 kg = 6.42

Salada de Manga E Camarão

a partir de 29.05.

a partir de 29.05.

D.3 Example of Personalized Vignettes (YouTube)

YouTube – Global Data (Week of 3 July)

Last week visits

Last week summary of visits

Page	Visits	Number of Visits per Session	Average Time on Page	Average Number of Clicks	Average Number of Missed Clicks	Average Scroll Depth
YouTube	40	1	1m20s	15	3	20 cm
The Music Channel	25	0,6	37s	2	1	3 cm
Trending	10	0,3	54s	1	1	40 cm
The Hit List	10	0,3	16m	4	2	2 cm

YouTube – Global Data (Week of 3 July)

Frequent tasks

Task	Frequency	Average Task Time
YouTube > The Music Channel	25	2s
YouTube > Trending	10	1.5s
YouTube > The Music Channel > The Hit List	10	4s

YouTube – Heatmap
Number of mouse clicks (from blue to red).
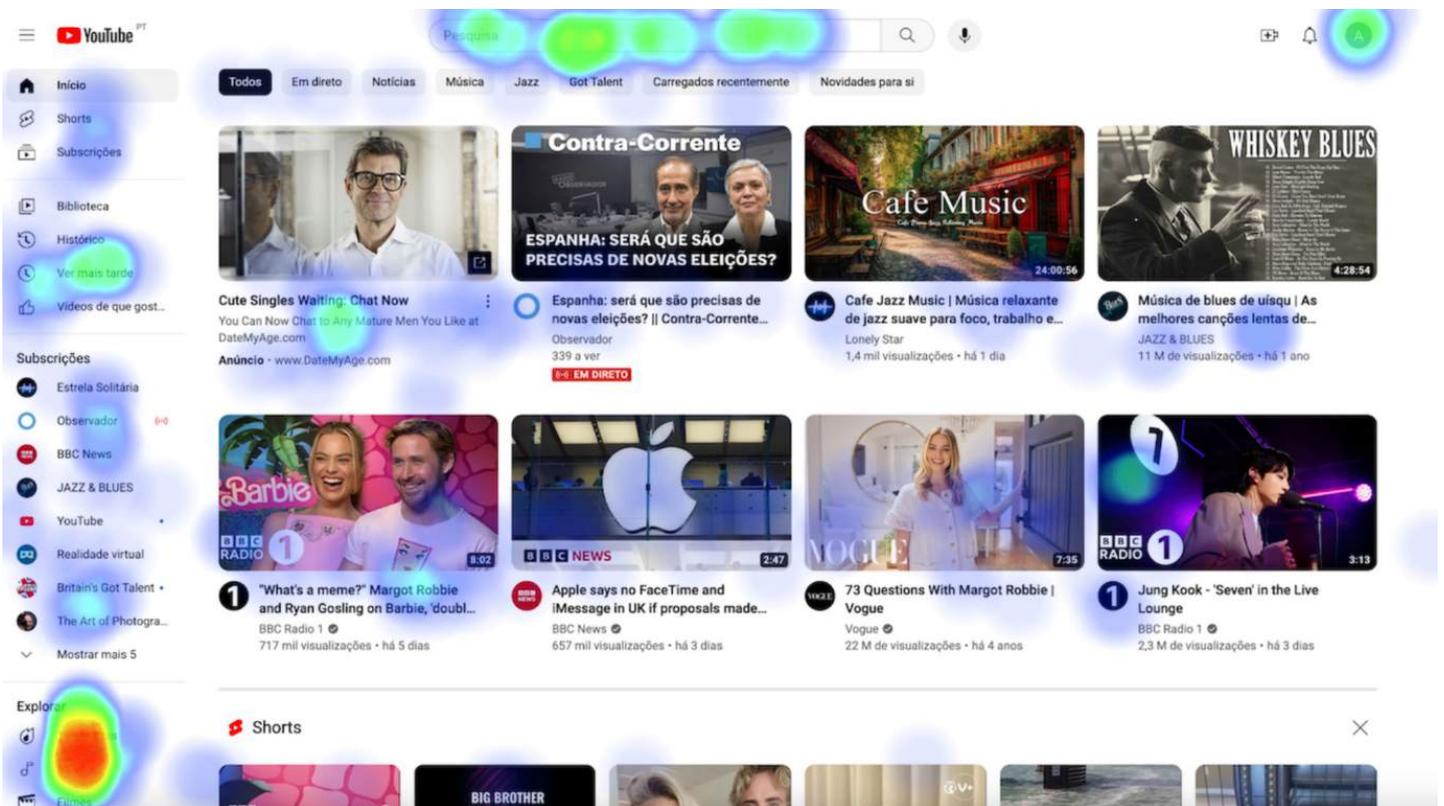
YouTube – Heatmap

Frequency of vertical scrolling for certain areas of the screen (from blue to red).
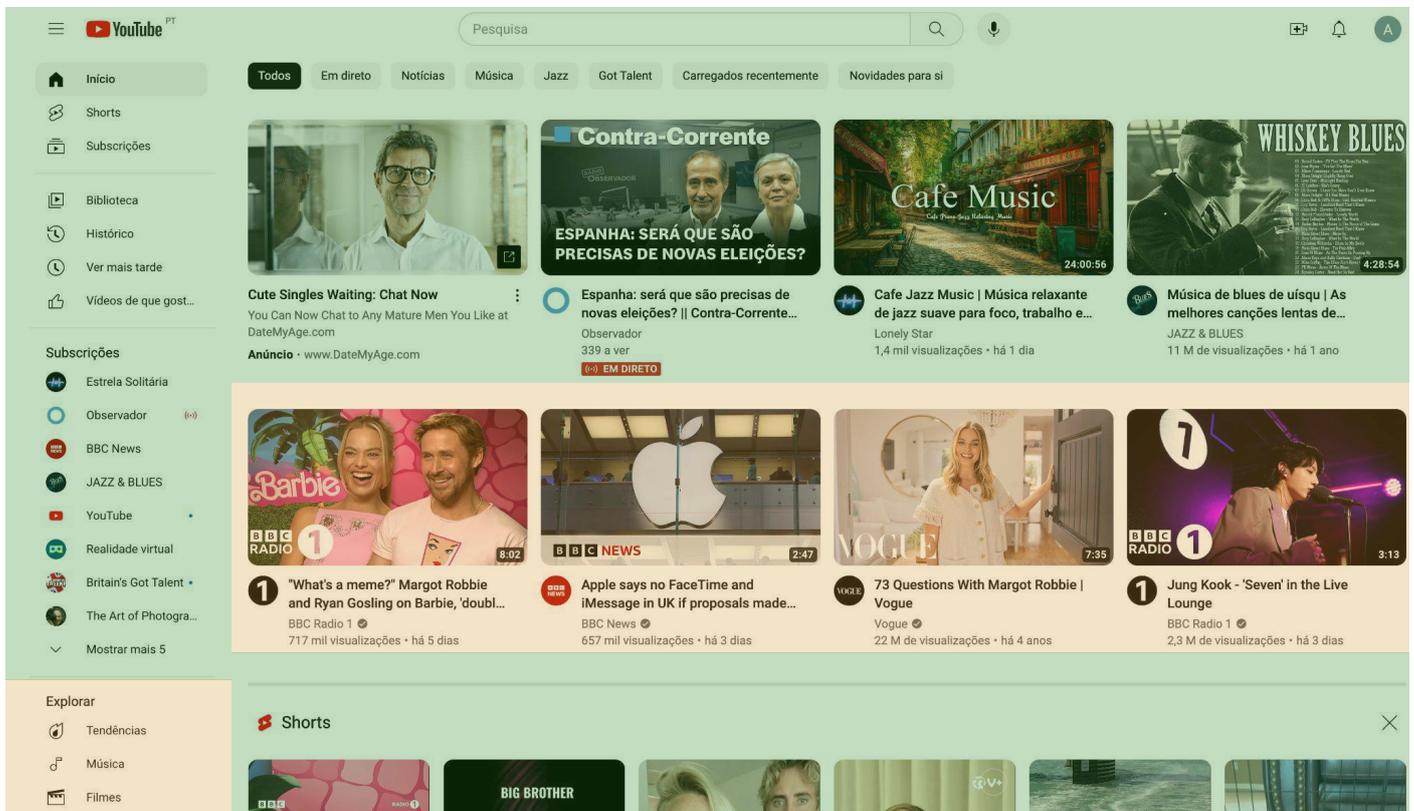
YouTube > The Music Channel – Heatmap

Number of mouse clicks (from blue to red).
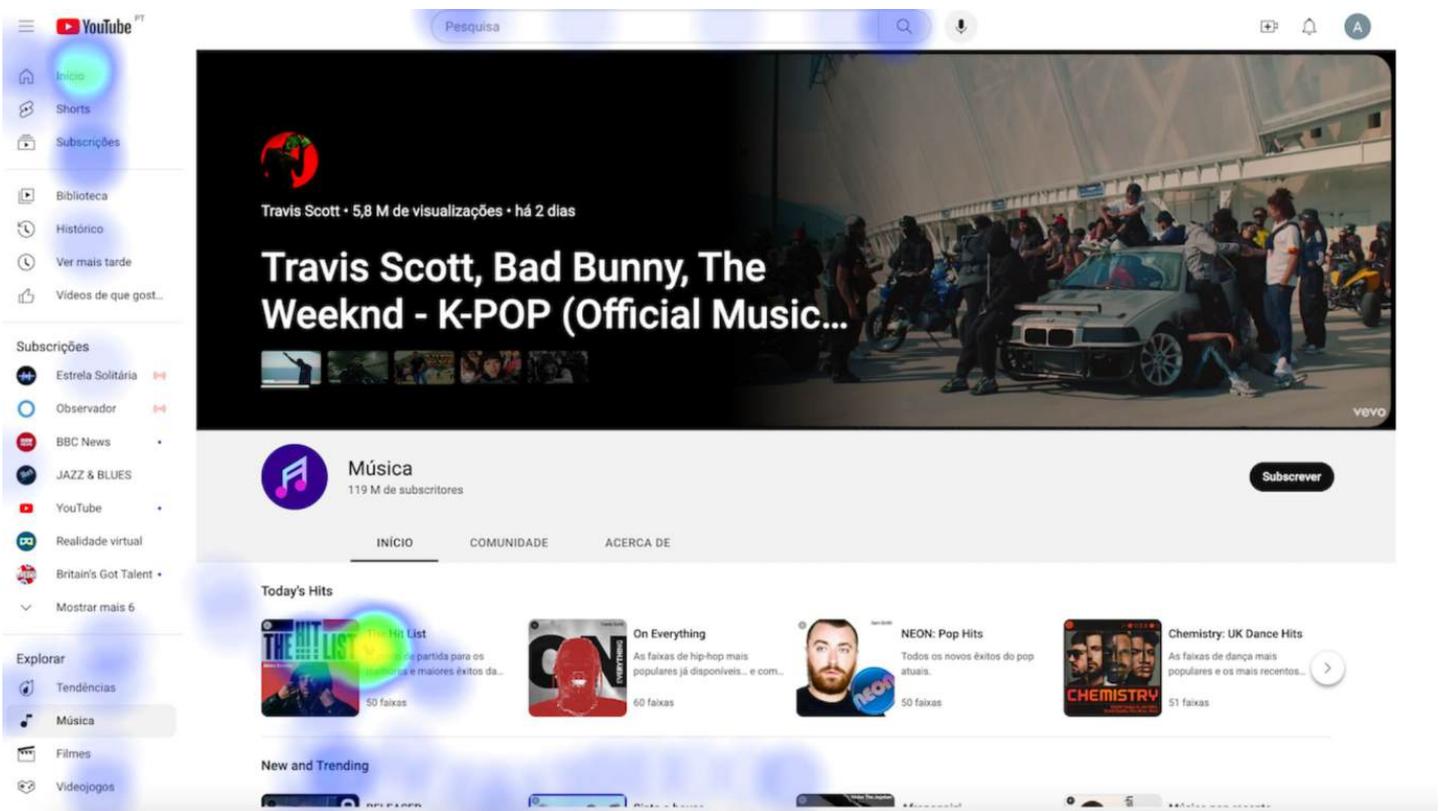
YouTube – Textual Suggestions

Based on your usage, we identified the following improvements.

Least used item.
Suggestion: Hide.

Most used menu items.
Suggestion: Reorder side menu.
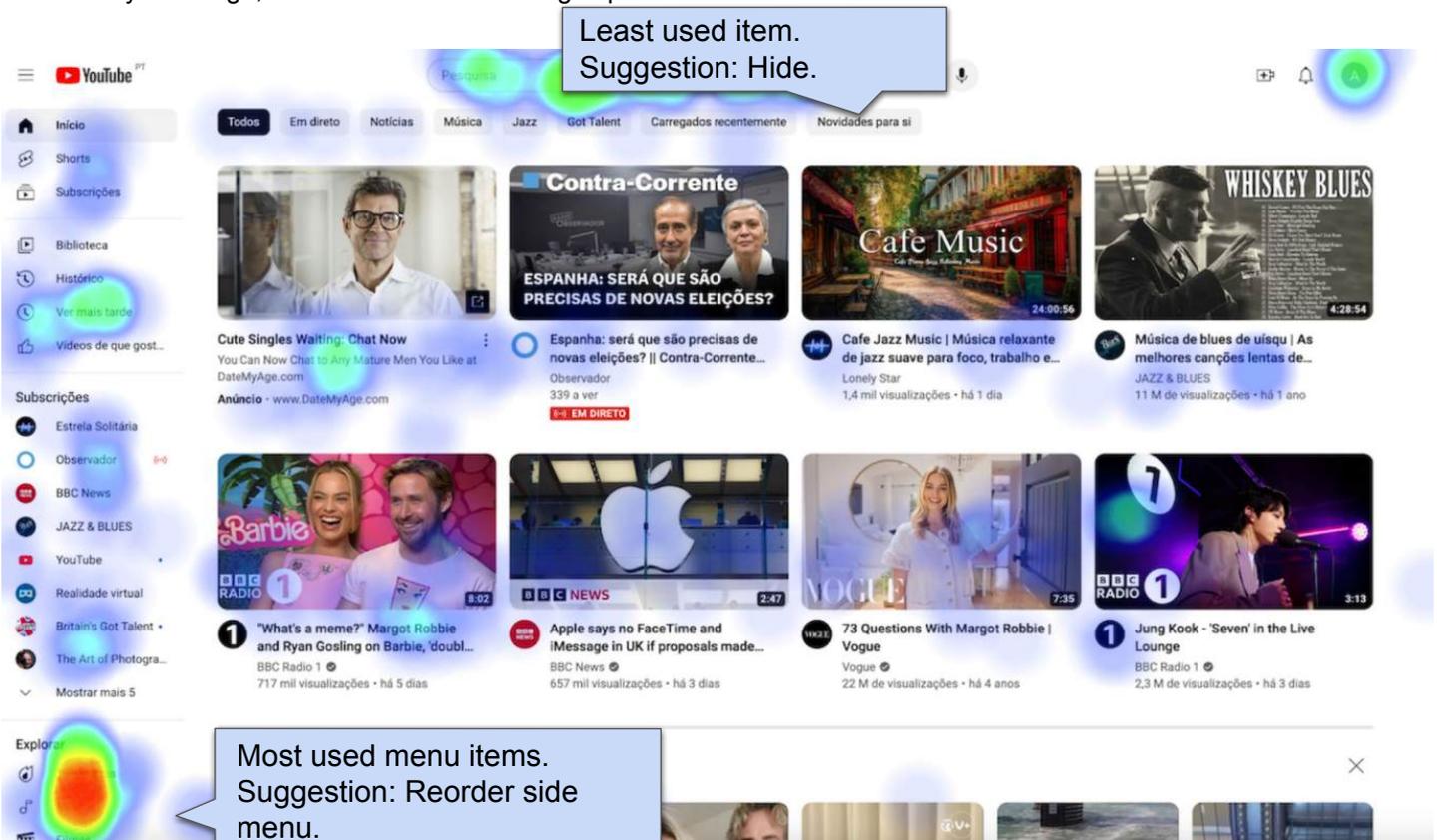
YouTube > The Music Channel – Textual Suggestions

Based on your usage, we identified the following improvements. We estimate that this personalization would require approximately two minutes, yielding a benefit of three seconds per visit.

Frequent task. Suggestion: highlight this element on YouTube.

YouTube – Visual Suggestions

Based on your usage, we propose the following changes.
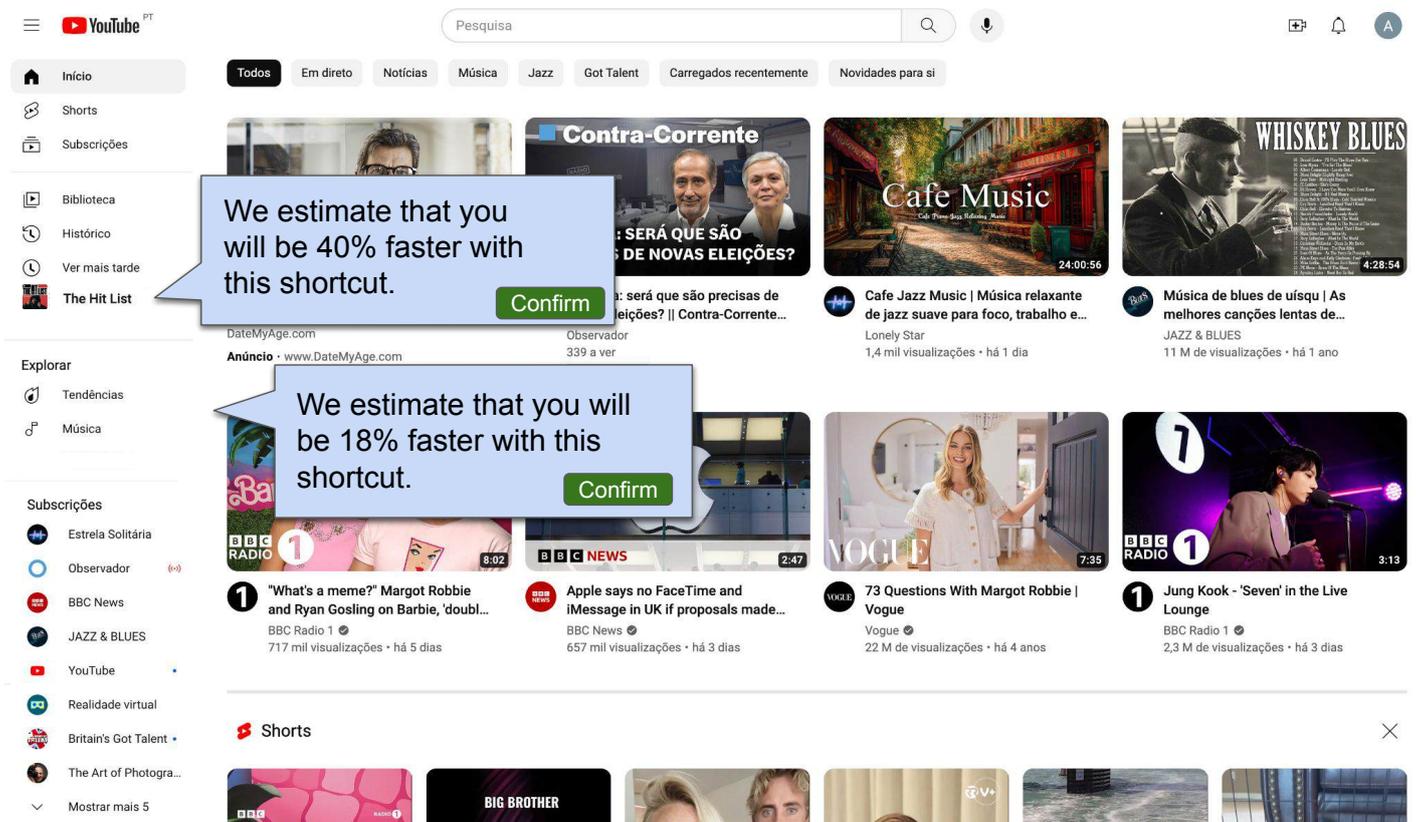
YouTube – Social Suggestions

Based on what other people like.

More than 500 users are using the following version of YouTube. Click to use this version.   Confirm

Other Materials

Pesquisa

Todos | Em direto | Notícias | Música | Jazz | Got Talent | Carregados recentemente | Novidades para si
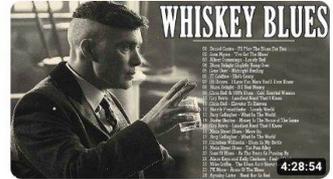
Cute Singles Waiting: Chat Now
You Can Now Chat to Any Mature Men You Like at DateMyAge.com
Anúncio · www.DateMyAge.com

Espanha: será que são precisas de novas eleições? || Contra-Corrente...
Observador
339 a ver
EM DIRETO

Cafe Jazz Music | Música relaxante de jazz suave para foco, trabalho e...
Lonely Star
1,4 mil visualizações • há 1 dia
24:00:56

Música de blues de uísqu | As melhores canções lentas de...
JAZZ & BLUES
11 M de visualizações • há 1 ano
4:28:54

"What's a meme?" Margot Robbie and Ryan Gosling on Barbie, 'doubl...
BBC Radio 1
717 mil visualizações • há 5 dias
8:02

Apple says no FaceTime and iMessage in UK if proposals made...
BBC News
657 mil visualizações • há 3 dias
2:47

73 Questions With Margot Robbie | Vogue
Vogue
22 M de visualizações • há 4 anos
7:35

Jung Kook - 'Seven' in the Live Lounge
BBC Radio 1
2,3 M de visualizações • há 3 dias
3:13

Shorts

BIG BROTHER

Pesquisa

Início
Shorts
Subscrições

Biblioteca
Histórico
Ver mais tarde
Vídeos de que gost...

Subscrições
Estrela Solitária
Observador
BBC News
JAZZ & BLUES
YouTube
Realidade virtual
Britain's Got Talent
Mostrar mais 6

Explorar
Tendências
Música
Filmes
Videojogos

Travis Scott • 5,8 M de visualizações • há 2 dias

Travis Scott, Bad Bunny, The Weeknd - K-POP (Official Music...

vevo

Música
119 M de subscritores

Subscrever

INÍCIO   COMUNIDADE   ACERCA DE

Today's Hits

The Hit List
O ponto de partida para os melhores e maiores êxitos da...
50 faixas

On Everything
As faixas de hip-hop mais populares já disponíveis... e com...
60 faixas

NEON: Pop Hits
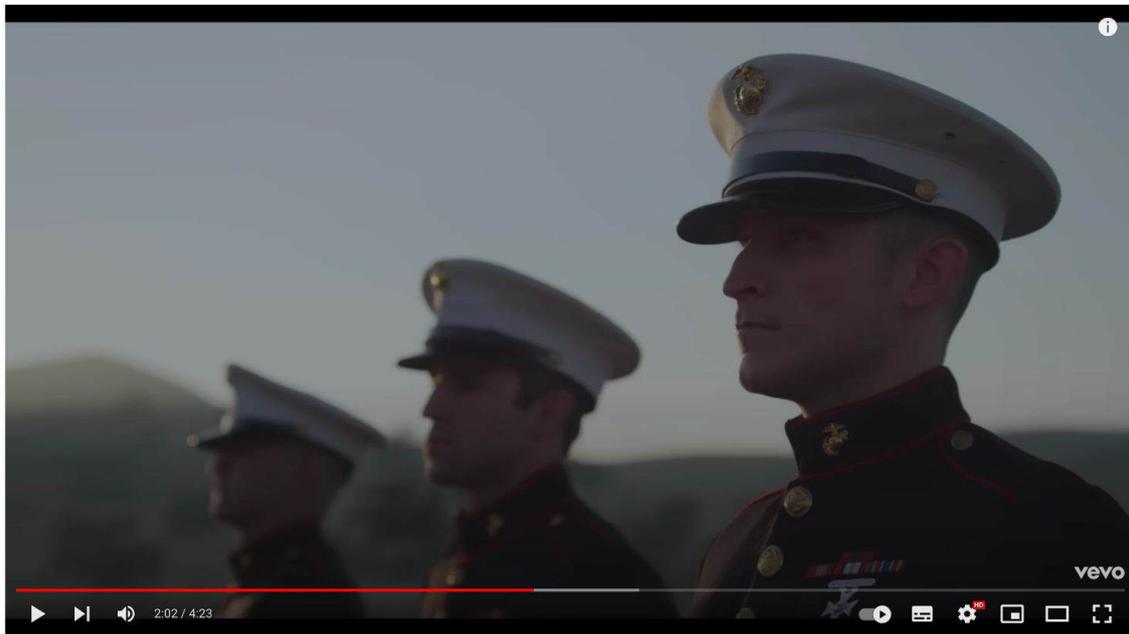Todos os novos êxitos do pop atuais.
50 faixas

Chemistry: UK Dance Hits
As faixas de dança mais populares e os mais recentes...
51 faixas

New and Trending

RELEASED

Sinto a house

Afrospi...

Músicas pop recente

Pesquisa

A

Todos | De AviciiOfficialVEVO | Relacionados | >

Avicii - Hey Brother

Avicii ♪
20,6 M de subscritores   Subscrever

👍 2,8 M   👎   ↪ Partilhar   ↓ Transferir   ✂ Clipe   •••

298 M de visualizações há 9 anos #Avicii #HeyBrother
Listen to more music by Avicii here: https://Avicii.lnk.to/Channel
In Dolby Atmos: https://avicii.lnk.to/SpatialAudio
Mostrar mais

Labrinth - Beneath Your Beautiful (Official Video) ft....
Labrinth ♪
334 M de visualizações · há 10 anos
4:28

Calvin Harris - Blame ft. John Newman
Calvin Harris ♪
837 M de visualizações · há 8 anos
4:15

Bastille - Pompeii (Official Music Video)
BASTILLEvideos ♪
733 M de visualizações · há 10 anos
3:53

Something Just Like This
The Chainsmokers ♪
268 M de visualizações · há 6 anos
4:08

Mr. Probz - Waves (Robin Schulz Remix Radio Edit)
Mr. Probz ♪
582 M de visualizações · há 9 anos
3:51

Shawn Mendes - Treat You Better
Shawn Mendes ♪
2,3 mM de visualizações · há 7 anos
4:17

twenty one pilots: Stressed Out [OFFICIAL VIDEO]
Fueled By Ramen ✔
2,7 mM de visualizações · há 8 anos
3:46

Mike Perry - The Ocean ft. Shy Martin
MikePerryVEVO
173 M de visualizações · há 7 anos
3:05

The Wanted - Glad You Came