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Improving the Usability of Intelligent Interface Designs

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ABSTRACT

By incorporating usability into the creation or evaluation of user interface designs, it is possible to provide experiences that are effective, efficient, and satisfying interactions for users. However, in systems that use Artificial Intelligence (AI), there may be challenges in evaluating these systems due to the complexity of real-world scenarios, uncertainty, or unique user interactions that may occur in such systems. The goal of this study is to identify and present possible evaluation guidelines to improve the usability of AI-based software systems. The methodology includes the synthesis of theoretical research results and the formulation of derived considerations. By synthesizing the results, a set of recommendations is presented to improve the knowledge of usability improvement in AI-based user interface design. The proposed guidelines aim at formulating a human-centered view of AI-based systems in order to improve the usability of such systems. The results show, for example, that usability and natural interaction between humans and AI can be achieved by personalizing results in such systems while respecting privacy, based on options such as configuration preferences.

Keywords: Artificial intelligence, Usability evaluation, User interface design, Guidelines, Natural interaction

INTRODUCTION

Artificial Intelligence (AI) methods are becoming more accessible and evolving - 2023 may be seen in retrospect as the year of exponential growth for AI (Escotet, 2023). As the user interface (UI) of systems using AI capabilities becomes more common, it may become increasingly important to prioritise an effective "whole user perspective". (Bingley et al., 2023), for example, noted that the focus should be on understanding what people need in their lives and how AI helps or hinders the satisfaction of those needs. In the context here, this means that human factors (Mukhtar and Ab Aziz, 2023), (Chignell et al., 2023) will have an important and significant impact. By focusing on the human perspective (e.g., (Amershi et al., 2019), (Xu, 2019), (Ahmad et al., 2023)), AI-based UIs can be optimized to provide tailored assistance, recommendations or support for different tasks and applications.

However, the difficulties that can arise from the interactions between AI-based UIs and the real world with its uncertainties can lead to inconsistent and unexpected results (e.g. (Jarrahi, Lutz and Newlands, 2022), (Smith, 2016), (Sarker, 2021), (Drzyzga, 2024)). Their evaluation is challenging, and the use of traditional design principles or well-known guidelines has its limitations (e.g. (Komischke, 2021)). In addition, the use of AI-based technologies

may raise additional issues of privacy, autonomy, fairness and accountability (e.g. (Rodrigues, 2020), (Bjørlo, Moen and Pasquine, 2021)). Ensuring that these challenges are addressed requires careful consideration during the design process.

BACKGROUND

Continuing previous research (Drzyzga, in preparation) at the intersection of AI and Human-Computer Interaction (HCI), this study focuses on improving the usability of AI-based software systems through guidelines for the UI design of such systems. This and a subsequent study have used an extensive literature review, including a validation and analysis process, to explore how AI can be incorporated into considerations of design criteria, and what the implications are for issues that arise between AI and HCI, particularly when evaluating UI design using established design principles (Drzyzga, in preparation). While these studies have shown the need to extend or add new design principles to address the unique challenges of human-AI collaboration, the focus of this study is to formulate concrete evaluation approaches that can improve usability and user experience (UX) in such complex and dynamic environments.

The question is how traditional usability principles need to be adapted or extended to improve the usability of UIs. A look at the current state of AI integration in interactive products in different domains (e.g. (Bingley et al., 2023), (Anderson and Fort, 2023), (Correia et al., 2023), (Ozmen Garibay et al., 2023)) suggests that (design) principles are evolving towards advanced concepts capable of addressing the unique challenges posed by, for example, probabilistic systems, personalization and real-world scenarios. By synthesizing theoretical research and deriving specific considerations for the evaluation of AI-based UIs, this study aims to provide a set of guidelines that can guide the design of human-centered experiences with AI technologies. The proposed evaluation strategies aim to promote understanding of how to improve usability in the context of AI-based UIs, how to ensure personalized outcomes while preserving user privacy, and how to promote natural interactions between humans and AI. This research contributes to the ongoing discourse on HCI in AI-based UIs by providing practical recommendations for improving UX and developing human-centered and effective AI-based software applications.

METHODOLOGY

Building on the previous research, this study aims to discuss this work in the necessary brevity and depth. As part of the discussion of the principles developed, a further focused literature review was undertaken to extend the findings and combine them with the results of the previous studies to identify common themes, knowledge gaps and areas where new design principles for AI-based UIs are needed.

Reviewing and Summarizing Previous Studies

Formulation of a set of guiding principles to assist in the incorporation of AI into interface design in future usability studies or projects. The aim is for

these guidelines to be clear and concise statements that summarise the main findings on the topic.

Conducting an Updated Literature Review

The focus will be on recent advances in human-centered AI research, addressing the challenges and opportunities of human-AI collaboration in software applications and interfaces.

Synthesizing the Findings

The findings are synthesized to identify common themes, knowledge gaps, and areas where new design principles for AI-based UIs are needed. Information about the principles and their characteristics is summarized and the essential aspects are formulated.

Formulation of a New Set of Design Principles

Building on the first set of design principles proposed in the previous studies, these guidelines will be extended or refined to address the challenges and opportunities identified for the collaboration of humans and AI in software applications and interfaces. This will result in a first set of guidelines to help understand how to improve usability in AI-based systems.

Review of Previous Studies

Incorporating AI into design criteria considerations (Drzyzga, 2024) demonstrated a significant need to explore this more thoroughly. The results showed a need for deeper understanding, so a subsequent theoretical-conceptual analysis of the application of traditional principles to AI-based UIs was undertaken (Drzyzga, in preparation). Based on this, the findings have been condensed. In this study, the first considerations of potential evaluation aspects for the improvement of the usability of AI-based software systems were made.

Through this comprehensive analysis of existing knowledge and recent advances in the integration of AI into (HCI) design principles, the aim is to propose a framework for the design of effective human-centered AI that promotes human-AI collaboration while respecting human factors in AI-based UIs.

Exploring the Fields of UX and AI-Based UIs

The need for adjustments to traditional design principles due to the integration of AI-based UIs into HCI arises when considering the unique characteristics and challenges of AI. The potential mismatch between user expectations and the automated results generated by an AI-based UI, which can lead to inconsistencies in the application of established design principles. Consideration should therefore be given to making AI-based UIs transparent about their results, for example through Explainable AI methods to address this issue (Mohseni, Zarei and Ragan, 2021). With this transparency and explanations, users should be able to better understand how the system arrived at its conclusions.

Furthermore, due to the probabilistic nature of AI systems (Wing, 2021), additional capabilities may be required to comply with these enhanced principles. This could include providing more configuration settings or considering all possible user actions and system states to give users control over their interactions with the AI-based interface and a better understanding of how it works.

Novel Principles for the Design of Human-AI Collaboration

The previous considerations of incorporating AI into design criteria (Drzyzga, 2024) and theoretical-conceptual analysis (Drzyzga, in preparation) have led to the identification of areas that are suggested for improving the usability of AI-based UIs. They can be grouped thematically as "Understanding the User", "Personalized Experiences through Contextual Understanding", "Information Openness", and "Cultural Sensitivity" are detailed as follows.

Understanding the User

Here, the use of Natural Language Processing (NLP) capabilities involves the use of linguistic patterns and commands derived from everyday or contextual scenarios to provide ways of facilitating interactions (e.g. (Chowdhary and Chowdhary, 2020), (Danilevsky et al., 2020). This includes a range of modalities, including textual or verbal communication (e.g. (Khurana et al., 2023), (Johri et al., 2021)).

For a better understanding, the system needs to be adaptable to ensure the continued relevance and usefulness of the UI, for example as user needs may change over time (e.g. (Libai et al., 2020), (Schuetz and Venkatesh, 2020)). The use of predictive analytics could enable the proactive provision of relevant information (e.g. (Bharadiya, 2023)) or options by anticipating potential future needs based on past patterns and trends (e.g. (George et al., 2023)). Identifying anomalies may maintain the quality of data analysis (e.g. (Li et al., 2023), (Lee and Cho, 2020)). Finally, learning from user interactions and feedback plays a role in improving system performance and overall UX by informing design iterations and decisions. (e.g. (Rzepka and Berger, 2018)).

Personalized Experiences Through Contextual Understanding

Contextualizing interfaces to adapt to different situations and user preferences, considering the physical environment and cultural context of the user (e.g. (Lee and Joshi, 2020)). The proposal is to develop UIs that are adaptive, tailored experiences based on contextual understanding.

Considering uncertainty, it is relevant to identify why outcomes may differ from expectations, and whether this is because the system has made the right decision but the user cannot interpret it correctly, or because the system misunderstands the user, or because it has made incorrect assumptions about the user (e.g. (Foidl, Felderer and Ramler, 2022)). Usability could be improved by tailoring interactions to the needs, preferences, interests and values of the individual user. Achieving this level of contextualization requires deep knowledge of the user's situational context, including their goals, behaviors and, in the best case, emotional state (e.g. (Jiang et al., 2023), (Marechal et al., 2019)).

Information Openness

This thematic involves providing options for accessibility to different user needs, as well as clear explanations of how data is used and stored by AI-based UIs. It takes a broader view and includes transparency, trustworthiness, accountability and responsible AI-based UIs development.

In this context, three areas have been identified: (1) general factors such as privacy, accessibility, accountability, explainability or ethical guidelines; (2) the specific concept of information, such as improved access to relevant data, documentation or explanations of AI model results or predictions (e.g. (Shin, 2020), (Kaur et al., 2023), (Adam, 2022), (Maalej, Pham and Chazette, 2023), (Kiseleva, Kotzinos and De Hert, 2022)); and (3) the traceability of results (e.g. (Mora-Cantallops et al., 2021), (Kroll, 2021)) as a factor, for example, "to maintain a complete account of the provenance of data, processes, and artifacts involved in the production of an AI model" (Mora-Cantallops et al., 2021).

Cultural Sensitivity

The considerations in cultural sensitivity are that it could be incorporated into interface design through localization, personalization based on cultural values, and ensuring that interaction preferences are consistent with cultural norms. In a diverse world, it is important that AI-based UIs take this into account, as well as differences in user preferences, values and behaviors. For example, policies on the processing and confidentiality of personal data may vary from one society to another. Such systems should therefore be designed to take account of different cultural backgrounds.

Some of the cultural differences that can help improve AI-based UIs include language processing, visual design, behavioral adaptation, personalization, accessibility, privacy and ethical considerations. In addition, understanding communication styles, information sharing practices, social etiquette, and interaction preferences can further enhance the cultural sensitivity of UIs (e.g. (Kopalle et al., 2022), (Amugongo et al., 2023), (Lee and Joshi, 2020), (Prabhakaran, Qadri and Hutchinson, 2022), (Miraz, Ali and Excell, 2022), (Zhou et al., 2022), (Reinecke, 2012)).

Summary

This paper identifies four key themes for improving human-AI collaboration through better UI design: Understanding the User, Personalized Experiences through Contextual Understanding, Information Openness, and Cultural Sensitivity. The guidelines focus on adapting AI-based UIs to better understand users' needs over time, providing contextually aware experiences tailored to individual preferences and cultural backgrounds, ensuring transparency in data use and storage, and maintaining traceability of results. By incorporating these novel design strategies, human-AI collaboration can become more effective, user-friendly and culturally sensitive, while maintaining ethical standards and accountability in the development of AI-based UIs.

CONCLUSION

This study focused on improving the usability of intelligent interface designs. The findings highlight the need to extend established principles, considered to develop new principles for human-AI collaboration, and emphasise user understanding, contextualization, information openness, and cultural sensitivity. In summary, by taking into account the aspects outlined above, a more understandable and trusting relationship can be established between humans and AI-based UIs. Taken together, they may allow the results of such a system to be personalized in such a way that privacy and personal configurations (manual or automated by the system) can be considered and enabled. Applying these considerations to improve the usability of intelligent systems may also lead to more intuitive human-AI interaction. A more natural human-AI interaction in such UIs, based on understanding and trusting collaboration, whether through text, speech or gesture recognition, could be the result.

It discussed and presented possible guidelines to improve the usability evaluation of AI-based UIs. The methodological approach included summarizing research findings, consolidating information into a set of initial guidelines, and presenting an overview of the results. It provides a potential basis for improving the usability of intelligent interface designs by outlining ways to address the unique challenges of integrating AI into UIs. For each of these aspects, there are a number of influencing factors (e.g. the user's prior knowledge or ability to interpret explanations) that should be considered in order to understand the complexities involved in their implementation in intelligent interface designs.

LIMITATION

Although the principles outlined may offer promising directions for improving human-AI interaction, several factors may limit their applicability or effectiveness (e.g. insufficient data, context modeling, privacy concerns, diverse training data); it is important to consider these limitations so that future research can address them and improve the current state of knowledge. It should also be noted that this theoretical research is mainly based on and a continuation of the results of one author's study and requires further evaluation in real-world environments. This highlights the need for further research and testing to validate the proposed considerations and ensure their effectiveness in improving the usability of AI-based UIs and human-AI collaboration.

OUTLOOK

As mentioned above, the effectiveness of the described principles should be investigated in future empirical studies. This will help to evaluate and, if necessary, refine the principles and associated criteria and formulate them accordingly. In addition, as AI technology is rapidly evolving, it is important to continually update these principles to ensure that they remain relevant and effective for new applications and contexts.

Despite the benefits of personalization, it is important to recognize and explore the potential problems associated with over-personalization. Further research is needed to find the right balance between personalization and maintaining an open dialogue with users in AI-based interactive software systems.

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