Exercises in Human-Centered AI: On Shneiderman's Second Copernican Revolution

Dieter Wallach[1], Lukas Flohr[2], Annika Kaltenhauser[2], Sven Fackert[1]

[1] Hochschule Kaiserslautern
dieter.wallach@hs-kl.de, sven.fackert@hs-kl.de
[2] Ergosign GmbH
annika.kaltenhauser@ergosign.de, lukas.flohr@ergosign.de

Abstract. In his stimulating paper "Human-centered Artificial Intelligence" Shneiderman (2020) reframed AI research and application development by putting human users at the center of system design. Shneiderman requests a reunification of the view where humans are in the loop around algorithms and AI and suggests putting AI in the loop around humans, with a dedicated focus on the needs of users. From a UX designer's point of view, we discuss the idea of putting humans at the center and illuminate the implications of Shneiderman's arguments by referring to projects from our lab. By this, we emphasize the role of empirical research, (collaborative) UX Design, and evaluation in the development of human-centered AI systems. Our case studies exemplify a human-centered design approach of AI-injected systems in different domains and carve out the core learnings we gathered. The first case study, IMEDALytics, is taken from a project targeted at the development of a clinical decision-support system (CDSS) for individualized medical risk assessment, monitoring, and therapy management in intensive care medicine. We select this project to illustrate the indispensable nature of ethnographic user research to arrive at a holistic understanding of user needs. By visualizing the results of contextual observations and interviews in comprehensive user journeys, we shift the focus from problem solving through technology to the design of experience potentials (see Hassenzahl, 2010). We argue that it is paramount to present information to physicians in an unambiguous and understandable way, which classifies the task as an Explainable AI example in which answers to the following questions need to be derived:

- How can we combine human abilities of healthcare professionals – such as their general understanding, previous experiences, flexibility and creativity in the decision-making process – with the powerful possibilities of an AI-based system?
- How can we make diagnosis and therapy suggestions provided by the system accessible to healthcare professionals without depriving their self-efficacy?
- Which design processes are needed to design an interactive interface that leads to a long-term positive UX?
- Which influence has (the type of) presented information – e.g., in the form of information visualizations – on the perceived transparency or even trust in a CDSS?

Our second example focuses on the development of real-world autonomous mobility-on-demand (AMoD) public buses and required services for their operation. In autonomous mobility-on-demand systems, passengers are transported by self-driving cars, i.e., by vehicles with high or full driving automation capabilities. Comparable to taking a ride in a (shared) taxi, journeys in AMoD systems are temporally and spatially flexible. This means that there are neither fixed timetables nor fixed pick-up or drop-off locations required. Given that there is neither a driver nor an accompanying assistant available to answer

traveler queries, AMoD rides vary greatly from current mobility-on-demand or taxi services. This new situation of riding in a driverless vehicle might feel awkward to passengers who are exposed to the decisions and actions of an autonomous system. Consequently, user interfaces capable of compensating the absence of a human driver are needed to establish a trustful AV-passenger communication. To counteract these challenges, we had to find answers to questions that include the following:

- How can and how should AI-infused AMoD systems communicate with passengers?

- How can we design and evaluate user interfaces while taking the complete user experience – before, during and after a ride – into account?

In our talk, we illustrate the applied formative design approach that is used for an iterative refinement of mobile and in-vehicle passenger UI prototypes (GUI- and Chatbot-based) and their subsequent empirical evaluation in simulators with increasing fidelity — ranging from video-based lab setups to real-word (Wizard-of-Oz) on-demand drives. In our third case study, AI science and AI engineering (Shneiderman, 2020) — i.e., emulating human behavior and developing useful applications — are combined in the creation of an AI-based (predictive) prototyping tool. The resulting tool allows the creation of complex interactive prototypes for which quantitative performance predictions are derived by running cognitive models. Such models are automatically generated by monitoring a designer's interaction while completing a task scenario using a prototype. The underlying models are based on the ACT-R cognitive architecture (Anderson & Lebiere, 2020) comprising hybrid (i.e., symbolic and sub-symbolic) structures and processes. ACT-R is a prominent example of a Unified Theory of Cognition integrating empirically supported assumptions about the interplay between human memory, learning, attention, perception and motor behavior which has been successfully applied to a broad range of tasks. The generated models can directly interact with a prototype, perceive its interface elements, learn task interactions and be able to manipulate the state of controls. In our talk we demonstrate that — by generating the behavior of synthetic participants — we can successfully predict human performance in real-world tasks ranging from mobile phone applications to the operation of commercial riveting machines in aviation industry. By using the very same tool, interface designers can create a prototype and receive almost instant evidence about its interactional efficiency by running artificial user models. Predictive prototyping opens the potential to significantly shorten iteration cycles by providing quantitative performance KPIs without the need to conduct effortful user studies. In the light of the case studies presented, we argue that the methodological apparatus of UX research and collaborative design practices contributes to the development of "human-centered" AI-based systems that result in positive user experiences — and thus increase the likelihood of adoption of AI-based systems in practice.

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