DESIGN PRINCIPLES FOR HUMAN-COMPUTER COLLABORATION

Extended Abstract

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User assistance systems are information systems that help humans perform tasks better (Maedche et al. 2016). Enabled by emerging technologies like artificial intelligence, the widespread adoption of these increasingly sophisticated systems is radically transforming the way humans work. Advanced user assistance systems can relieve employees from mundane or repetitive work and allow them to focus on more complex work (Maedche et al. 2016). As the field of artificial intelligence is advancing quickly, computers can perform an increasing number of tasks which were previously performed by humans. However, in a vast number of cases, computers still need the help of humans to achieve acceptable levels of performance. The interplay between such systems and humans remains a challenge. In many cases, the capabilities and functionalities of user assistance systems have increased rapidly in the last decade, while the ability of humans to comprehend and utilize these systems has not kept pace (Gorecky et al. 2014, Kagermann 2015). There is evidence that these emerging systems will eventually shift the majority of tasks from humans to computers (Manyika 2017, Leopold et al. 2018). However, today there are still many problems that computers cannot solve alone (Kamar 2016). That is the case, for instance, with complex planning problems where companies rely on the tacit knowledge of their employees. As this circumstance will not change in the foreseeable future, there is a need for systems that complement and augment human capabilities instead of aiming to replace them. Hence, we argue that information systems need to be designed to support human-computer collaboration. We explore design principles for these "human-in-the-loop" systems that facilitate the collaboration of humans and computers (Holzinger 2016).

To take advantage of human-computer collaboration companies must understand how humans can effectively augment computers, how computers can enhance what humans do best, and how business processes have to be designed to support this partnership (Wilson & Daugherty 2018). We study human-computer collaboration in the context of user assistance systems by instantiating various machine learning artifacts in an industrial application context. In particular, we explore interactivity as an essential design aspect of user assistance systems and examine its influence on the trust of users in the system as well as the accuracy of the joint predictions.

We conduct a field study in the context of personnel planning in system catering restaurants—and more specifically focus on the forecasting of revenue as an essential prerequisite of personnel planning. In the gastronomy sector, wages account for one-third of all costs. Accordingly, restaurateurs try to optimize the utilization of their employees by creating suitable work schedules. To do so, restaurateurs have to forecast the daily and weekly revenue of their restaurants to assign employees to shifts. Estimating the fluctuating revenue is a difficult task that requires weighting multiple factors (e.g., historical revenue, weather, events). While computers are skilled at modeling general tendencies of time series (i.e., trend and seasonality), we know that restaurateurs rely on a variety of factors that are complicated to incorporate into traditional forecasting methods due to their rarity and uniqueness (e.g., events). These complementary capabilities of humans and computers combined with the concreteness of the task (i.e., forecasting revenue) provide a promising opportunity to study human-computer collaboration. Following the design science research paradigm (Sonnenberg 2012), we develop a software artifact with a case company to empirically answer our research question.

Our contribution is fourfold: First, we address a crucial real-world issue in personnel planning, namely the need for predicting revenue as a prerequisite for assigning employees to shifts. Based on design requirements derived through expert interviews, we develop prototypes that incorporate the expertise of users in the revisioning of automated forecasts. We further conduct a focus group with domain experts to refine the prototypes before developing software artifacts. Second, we conduct a comprehensive evaluation of the software artifacts through a field experiment with high external validity. Third, we gain insights on the influence of interactivity on trust and accuracy as proxies for human-computer collaboration. Forth, we refine and discuss two design principles for the facilitation of human-computer collaboration in advanced user assistance systems.

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