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CHATBOTS AND THE NEW WORLD OF HCI

Authors:
Asbjørn Følstad, Petter Bae Brandtzaeg

A potential revolution is happening in front of our eyes. For decades, researchers and practitioners in human-computer interaction (HCI) have been improving their skills in designing for graphical user interfaces. Now things may take an unexpected turn—toward natural language user interfaces, in which interaction with digital systems happens not through scrolling, swiping, or button clicks, but rather through strings of text in natural language. This is particularly visible in recent developments in chatbots, that is, machine agents serving as natural language user interfaces to data and service providers [1], typically in the context of messaging applications. Need a reminder to pick up some flowers for your husband on the way home? Ask Jarvis the chatbot to remind you. Wonder if you should bring an umbrella to that meeting in Stockholm? Send Poncho the artificial weather cat a message and ask. If technology giants like Google, Facebook, and Microsoft are right, we will be moving our digital interaction from websites and apps with graphical user interfaces to messaging platforms such as Messenger and Allo. If this happens, huge challenges and opportunities await in the field of HCI.

Let's have a look at what is happening in the still relatively exotic world of chatbots. In early spring 2016, Microsoft presented its vision of *conversations as a platform*, where artificial intelligence (AI) and natural language interaction allow new ways to experience interactive systems. As a step toward this vision, the company provided a framework for bot developers and launched the first chatbots on Skype. Microsoft, however, is far from alone in holding visions of natural language interaction. At about the same time, Facebook launched facilities for building chatbots for its messaging application, Messenger. Already, tens of thousands of chatbots have appeared on Messenger. Though the vast majority of these are useful or entertaining for only a tiny group of people—maybe only their developers—some pleasant surprises point to the opportunities ahead. For example, Smokey warns you when the air quality in your city drops below acceptable levels; Instalocate helps you stay updated on your upcoming flights; and Jessie Humani takes you for an entertaining ride through the everyday life of young adults. Then there is Google Assistant, a chatbot integrated into the Allo messaging application and recent versions of the Android operating system that outperforms all the others, though it too can be pretty dumb at times. Google Assistant reliably helps you out with questions in natural language, such as when the sun sets or where to find the nearest coffee shop, even when asked follow-up questions for directions or opening hours. Yet conversations break down fast enough for this to be an interface for only the most enthusiastic of techies.

↑ **Insights**

→ Major technology companies see chatbots and natural language user interfaces as the next big thing.
→ Natural language as a preferred interface for interacting with digital services has many implications and opportunities for the field of HCI.

It is no mystery why the major technology companies see chatbots as the next big thing. Mobile messaging applications now have more than 1.5 billion users worldwide [2], and they are competing with social networks as the main user interface to the Internet. For many users, natural language is already the default mode of interaction online, only there, the interaction is typically between human users through a machine interface. At the same time, advances in AI mean that natural language interaction may be a feasible option for connecting machine agents and human users [3]. This already is visible in Twitter, a service that is welcoming to machine agents to the extent that this has become a social network arena for humans and bots alike. During the 2016 U.S. presidential election, it was estimated that more than one-fifth of the tweets using the main election hashtags were generated by machine agents, potentially affecting the outcome of the election [4]. There has also been concern regarding the potential of automated Twitter accounts for promoting political positions in the 2017 French presidential and German federal elections.
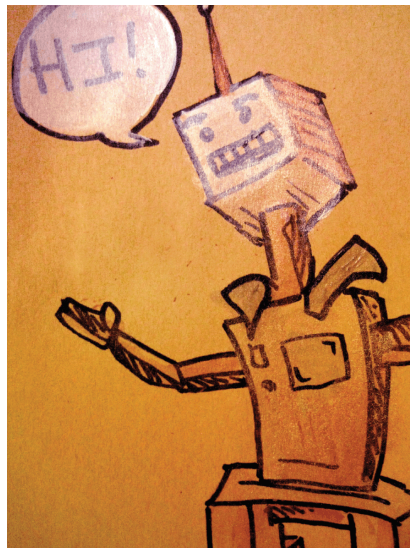
For commercial and nonprofit service providers alike, natural language user interfaces are on the verge of becoming an attractive interface through which to engage with customers. Companies like Domino's Pizza and Taco Bell are trying out chatbots as booking agents in messaging applications. Medical chatbots, such as Cardea, are providing health advice and doctor listings. Governments are exploring chatbots as a means for facilitating voting in elections. The authors of this paper are currently exploring how chatbots may provide youth with support on mental health issues [5]. In the not-too-distant future, chatbots may be the preferred user interface for many of the activities to which we have grown accustomed to performing through a webpage or a dedicated application. This popularity leads to an important question: What implications will the rapid developments and uptake of chatbots have for how we approach the design of interactive systems in HCI?

↑ **Implications For HCI**

Microsoft CEO Satya Nadella likened the foreseen transition to chatbots and natural language user interfaces to previous revolutions such as the introduction of the graphical user interface, the Web, and mobile Internet. Facebook CEO Mark Zuckerberg proclaimed chatbots to be a solution to the challenge of app overload. If the vision of conversational interfaces holds true, major changes are in store for the field of HCI.

In the not-too-distant future, chatbots may be the preferred user interface for many of the activities to which we have grown accustomed to performing through a webpage or a dedicated application.

I can already hear you protesting: *Natural language user interfaces are nothing new to the field of HCI. In fact, HCI researchers have studied these before, for example, in the context of multimodal systems, interactive voice-response systems, voice control in the context of accessibility, and conversational systems* [6]. Nevertheless, the bulk of usability research and practice arguably concerns graphical user interfaces and, to some extent, hardware design. As a field, we have spent the past two decades refining how to design for interaction with webpages or apps, drawing on ever richer interaction mechanisms to support usability and user experience.

A transition to chatbots and natural language user interfaces has many implications. The following are particularly noteworthy.

Conversations as the object of design. Design for chatbots represents a transition from the design of visual layout and interaction mechanisms to the design of conversation. In the current era of graphical user interfaces, designers benefit from substantial control of visual design and interaction mechanisms, allowing for detailed presentation of the features and content of an interactive system. Here, design for usability concerns navigation through menus and links, the browsing of content, and interaction with graphical elements. In the future era of chatbots and natural language user interfaces, the designer repertoire of graphical and interaction mechanisms will be greatly reduced. Indeed, current messaging dialogues allow for the inclusion of images, video, sound, and textual elements. However, the user interface is to a much greater degree a blank canvas where the content and features of the underlying service are mostly hidden from the user, and where the interaction is more dependent on the user's input. Here, design for usability involves suggesting to the user what she may expect in the service and the adequate interpretation of her response.

Seeing conversations as the object of design clearly represents a challenge to the field of HCI. We need to move from seeing design as an *explanatory task*—that is, a task of explaining to the user which content and features are available and which steps to take to reach the desired goal—to an *interpretational task*—that is, a task of understanding what the user needs and how she may best be served. At the same time, this challenge may strengthen our understanding of how to dynamically adapt the user interface as the dialogue with the user evolves.

The need to move from user interface design to service design. HCI research and practice have, to an overwhelming degree, addressed the design of specific user interfaces. That is, our attention as a field has been directed toward the object of design (the interactive system) rather than the user's goals. This is reasonable, given our grounding in software engineering and systems design. However, the transition to natural language user interfaces may imply a need to rethink this focus.

Currently, chatbots are embedded in messaging services. In the future, they may be in purely voice-based dialogue systems, like their precursor, Amazon's Echo. The same natural language interface will be used whether the user is chatting with a friend, arguing with her mother, or asking a chatbot for help with making New Year's Eve reservations. Interactions, services, and content previously demarcated by different webpages or apps will blur into the same conversational threads. In the future era of chatbots and natural language user interfaces, content and services do not differentiate by their user interfaces but rather by their convenience in accessing the context of conversational threads. For researchers and practitioners, this implies designing for entire service processes across conversational touchpoints with the user, rather than specific user interfaces. Here, we will have something to learn from the emerging field of service design.

The need to design for interaction in networks of human and intelligent machine actors. Design in HCI often concerns one user, one device. This is particularly true with regard to interaction design. Here, the object of design and evaluation is typically the user interface, as it will be perceived and acted on by a single user. This is not to say that other approaches to design do not exist. For example, the bordering fields of game design, computer-supported collaborative work, and design of sociotechnical systems have explored design for multi-agent systems.

In the future era of chatbots and natural language user interfaces, the multi-agent aspect of interaction design must be accentuated. This need to consider design in the context of networked intelligent machine actors is already seen in social networks. In March 2016, Microsoft launched Tay, a machine-learning Twitter chatbot simulating a teenage girl. Tay was set up to learn and improve from interactions with other Twitter users. Within hours of deployment, the chatbot was turned into a monster of derogatory and insulting remarks learned from the users approaching it. Chatbots can also work against other chatbots. For example, research on bots supporting the maintenance of Wikipedia articles suggests that different bots often end up reworking one another's editing work [7].

When conversation threads are populated by multiple actors—human users and chatbots alike—designing for interaction in networks becomes a prominent challenge.

↑ **New Opportunities**

In the future, HCI may need to consider conversations as the main object of design, focus on services rather than user interfaces, and design for interaction in networks of human and machine actors. All these changes reflect an underlying need to reorient HCI research and practice to meet the challenges of the future era of chatbot and natural language user interfaces.

As a result, it may be beneficial to take a step back and recap not only the challenges but also the opportunities that present themselves in this new landscape, especially opportunities that present themselves to researchers and practitioners of HCI, given the competencies and capabilities we have developed within this field.

We are confident that the opportunities outnumber the challenges. In the following, we highlight four areas of research.

Combatting digital divides. First, chatbots are supposed to communicate with people across gender, age, language, and preferences. However, research such as our own [8] suggests that new technologies often create new digital divides and biases across gender, age, and societal status. Chatbots hold great potential as an inclusive technology. A well-designed natural language interface should support uptake of digital technologies and services across groups that are less tech-savvy.

Nevertheless, chatbots are typically set up following a one-size-fits-all approach, in which all users, regardless of needs, preferences, and degrees of digital literacy receive responses in the same language by way of the same underlying set of data and services. Hence, an important question is whether the language and perspective reflected in such one-size-fits-all setups introduce undesirable biases. A male-dominated tech culture has resulted in the slang term "brogramming," referring to computer code produced by "bros" (male friends). In this context, the knowledge and experience of HCI researchers and practitioners from user research and analysis will be essential to identifying and combating digital divides as they appear for chatbots. Possibly, somewhere down the road, chatbots powered by AI may support personalization to a degree that such biases and divides are mitigated.

Understanding conversational processes. A key success factor for chatbots and natural language user interfaces is how well they can support conversational processes while providing useful output. The current state of the art is arguably Google Assistant and its ability to hold a conversational thread across several steps in a dialogue. However, even with Assistant, the conversation ultimately breaks down and the input from the chatbot becomes irrelevant.

In part, an adequate conversational process depends on massive developments within AI, drawing on deep learning from large volumes of interaction data. However, as misinterpretation is always a possibility in dialogue, chatbots as conversational agents need to be designed for both guiding the user toward attainable goals and providing acceptable responses in the case of conversational breakdown. As a field of studying interaction processes and error recovery, HCI will no doubt have much to contribute toward well-functioning conversational processes between chatbots and human users.

Benefiting from massive volumes of user data. HCI has been preoccupied by user-feedback evaluation since its beginning. Design and redesign are, by default, driven by trials involving users or usability experts, allowing for iterative improvements in designs. In particular, qualitative data has been key to such feedback practices, where the observations of users have alerted designers to usability problems and opportunities for redesign. However, sufficient access to users and data for evaluation has nearly always been an issue in the field. Not so for chatbot interaction.

In the future era of chatbots and conversational interfaces, HCI researchers and practitioners may benefit from access to massive volumes of user data. As the default mode of interaction is natural language rather than the clicking of links and buttons, users' intentions and levels of understanding will be significantly more accessible than what is the case in current interactive systems log data. Benefiting from this data source will require HCI researchers and practitioners to navigate uncharted territory in terms of data analysis, as well as ethics and privacy. However, the potential reward will be substantial.

Safeguard ethics and privacy. A final opportunity for HCI researchers and practitioners within the new world of chatbots and natural language user interfaces is to provide needed guidance on ethics and privacy. Novel technologies entail novel ethics and privacy implications, and chatbots are no exception. Interaction in natural language with multi-actor threaded conversations is a context where ethical and privacy challenges will flourish. Furthermore, the intelligent use of chatbots for persuasive purposes may entail important societal implications. As such, machine agents may be used to sway individuals' opinions in undesirable ways.

HCI researchers and practitioners have traditionally been forerunners in issues of ethics and privacy, as seen, for example, in the concern for these in the context of social networks. With the emergence of chatbots, even stronger attention on ethics and privacy is needed.

↑ Conclusion

The field of HCI has already seen several waves and has proven to be a discipline that enthusiastically takes on novel perspectives and technological opportunities as they emerge. Chatbots and AI-powered conversational interfaces represent a new world to be conquered. For that to happen, HCI researchers and practitioners should consider taking on human-chatbot interaction design as an area of research and practice. We have provided an initial overview of the challenges and opportunities of this new world. Now it is up to the HCI community to take these on.

↑ Acknowledgments

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↑ Authors

Asbjørn Følstad is a senior researcher at SINTEF. His main research interests are human-computer interaction and human-centered design. He coordinates the EU H2020 project HUMANE on human-machine networks. He has a Ph.D. in psychology from the University of Oslo. asf@sintef.no

Petter Bae Brandtzaeg coordinates the research projects Human-Chatbot Interaction Design and Social Health Bots, supported by the Research Council of Norway. His main research interests are patterns of use and the implications of new information and communication technologies. He has a Ph.D. in media and communications from the University of Oslo. pbb@sintef.no

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