

# On The Intersection Of Human-Computer Interaction (HCI) And Artificial Intelligence (AI)

## **Hendrik Heuer**

KTH Royal Institute of Technology  
EIT ICT Labs Master School  
[hendrikh@kth.se](mailto:hendrikh@kth.se)

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## **Abstract**

This paper explores the intersection of Human-Computer Interaction (HCI) and Artificial Intelligence (AI) and identifies opportunities for future collaboration. Based on a literature review, the historic relationship of the fields, their theoretical foundations and possible applications are discussed.

## **Author Keywords**

HCI; AI; Machine Learning; Semiotics

## **Introduction**

New interaction design paradigms will be required for the applications of the future. Internet of Things, Smart Spaces, Wearable Technology, Robotics and Massive Open Online Courses all have unique requirements. This paper explores theoretical and practical commonalities between HCI and AI.

## **Background**

When Lieberman published an opinion piece about the relationship between the fields of human-computer interaction and artificial intelligence, he concluded that they ultimately have the same goal - making user interfaces more effective and easier for people to use – and that together, the community can make user interfaces smarter and less frustrating to use [7]. McCarthy defined Artificial Intelligence (AI) as “the

science and engineering of making intelligent machines, especially intelligent computer programs" [9]. Douglas Hofstaeder cites Tesler's Theorem stating "AI is whatever hasn't been done yet" [4]. AI and HCI are regarded as two fields divided by a common focus [3]. As Grudin demonstrated, AI was focusing on long-term projects that ran on expensive systems, while HCI focused on short-term projects running on commodity hardware [3]. There is also a historic dichotomy between McCarthy's view of artificial intelligence as a kind of "superbrain" and Douglas Engelbart's goal of "augmentation" of the human mind [8]. Winograd's work shows a shift across this divide between HCI and AI [20]. Both AI and HCI are subfields of Computer Science, which is fundamentally postmodern and interdisciplinary [21]. Computer Science doesn't have a unique subject, but rather applies techniques to certain domains [21]. Nake motivates a paradigm shift from the Turing concept of computability to a media concept of interaction [10]. Nake advocates a semiotic view and introduces the algorithmical sign, that is simultaneously determined by a process of interpretation and determination [11]. Brains and computers can both be described as symbol systems [16]. The physical symbol system hypothesis states that "a physical symbol system has the necessary and sufficient means for general intelligent action" [16], thus there is also a semiotic connection to Artificial Intelligence.

### **Discussion**

Describing the usage of a computer as a semiotic process between humans and computers is both expressive and allows for substantial generative power. Taking the semiotic perspective into account, it could give rise to a variety of projects on the intersection of AI and HCI that have both more available methods and

a deeper theoretical foundation. These could be employed to realize Douglas Engelbart's vision of "improving the effective utilization of the intellectual power of society's problem solvers" [1]. This could take the form of user-centered, evaluation-focused experiments on systems that utilize the means of artificial intelligence, pattern recognition and data science. Exploratory data analysis, as described here [12], could become a well suited technique both as a method and as a subject for interaction design. Especially since the number of available sensors and the produced data are rapidly increasing. There is already research that aims to enable and facilitate a shared understanding of the digital material [18]. This is a good starting point, even though it is still limited to materials. In a more holistic way, the explorative approach could be extended to whole topics and research questions. An exploratory data analysis approach could also help strong concepts. Strong concepts are contestable, defensible, substantive and abstract patterns [5]. The data science toolset could help identify and substantiate strong patterns like social navigation, e.g. by visualizing multidimensional data, exposing correlations and enabling exploratory data analysis. More generally, a connection of AI and HCI could enable users to more easily and thoroughly analyse a variety of information sources and data streams. A noteworthy interdisciplinary research project is the "The Human Speechome Project Symbol Grounding and Beyond". The Speechome used audio-visual recordings for a longitudinal study on language development of a single child. The data was then analysed to understand more about language acquisition [15]. This can be used for research, but it could also be applied to inform the lives of people, e.g. in regards to their personal health and their finances.

Lieberman suggests that handwriting and voice recognition will become an important application domain for both HCI and AI technology [7]. Even though they gained a bad reputation as the first generation of implementations did not work, Moore's law will eventually make statistical language models powerful enough to reliably solve handwriting and voice recognition [7]. Deep learning research already showed that it is possible to train a face detector without having to label images as containing a face or not and that unsupervised learning is capable of automatically learning high-level concepts such as cat faces and human bodies [6]. There have been various publications in regards to interactive machine learning [2,17,19]. Interactive machine learning was proposed as "a natural way of integrating background knowledge into the modelling stage" [19]. One of the goals was to enable users to "work hand-in-hand with machine learning systems" [17]. This was explored using a think-aloud study [17], a method commonly used in HCI.

### **Possible Applications**

The synergies of artificial intelligence and human-computer interaction, especially interactive machine learning, could become very relevant in medical and business applications. It could also become a crucial tool in realizing Seymour Papert's dream of "computational fluency for everyone" [14]. Resnick suggested that this will require a new generation of technologies, activities, and educational strategies [14]. Papert evoked the notion of a Mathland, a place where mathematical thinking is natural – like speaking French is natural in France [13]. Papert wrote that while children may have problems learning French in French class in a U.S. school, all children in France will

eventually learn French. Such a Mathland could be realized using interactive machine learning. The system could both assess how much a user already knows about programming (which equals to how big his or her vocabulary is) and what he or she is likely trying to achieve (which equals to his or her intentions and which is similar to how a human language teacher asks the right questions to guide a student). Like in Human-Human Interaction and communication, the best interactions are based on a deep understanding of each other and correctly inferring the inner state as well as the intentions of the other. Like a teacher, who knows what a student understood and what he or she didn't and who also knows how to help him or her advance (a Socratic idea of the teacher as a midwife). Statistical machine learning methods could give users the right amount of support and assistance and enable developers to create better user experiences. Proactive and supportive technology could become helpful in personal health tracking, smart home management, personal finance management as well as interdisciplinary science. But it could also make programming easier and greatly improve education.

### **Conclusion**

AI and HCI could mutually benefit from a closer collaboration. The AI community could increase their usage of HCI methods like the Thinking aloud protocol and Wizard of Oz prototyping and take social constructivist positions into account. HCI could further augment human capabilities using new technologies. Both disciplines can be theoretically founded by semiotic theory. An interdisciplinary team of AI and HCI researchers could develop unprecedented applications, e.g. by improving education and making homes smarter.

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