HCI part 10

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1 Introduction

The task for this week is to read one article to describe what I have learned in each section of each document(around 1 page and a half) and to create/enhance an **adaptive** interactive system with adaptation. The article is **Cross-fertilisation between human-computer interaction and artificial intelligence**[1].

2 Cross-fertilisation between human-computer interaction and artificial intelligence

2.1 Abstract and introduction section

The article discusses the intersection of Human-Computer Interaction (HCI) and Artificial Intelligence (AI) and how these two disciplines have complemented each other since their inception. The article focuses on three domains: **intelligent user interfaces**, **capitalization**, **formulation**. The methodology makes use of **ergonomic knowledge** for the design and evaluation of interactive systems, and the **synergy between visualization and data mining**. The article argues that the success of new technology depends on the intelligent and meaningful integration of various methods, techniques, and systems from both HCI and AI. The article concludes by advocating for a more comprehensive approach to system design that incorporates both intelligence and interaction while taking into account the use of computer science and social sciences in concert to achieve the human-centered design.

2.2 History of interfaces between HCI and AI: a genesis

This section provides a **historical account** of the evolution of the interface between AI and HCI. The section describes how AI studies intelligent agents and how HCI studies devices to be used for the control of and communication with a machine, or with other people through a machine. It highlights how **automation** and the **development** of rule-based systems in the aviation industry, where new human errors were seen due to limitations of the technology at the time, necessitated the incorporation of human-computer interaction (HCI) to deal with new types of human errors. It was only with a more **mature technology** that the modern user interface in the cockpit called the "**interactive cockpit**", was developed. The section emphasizes the **importance of cognitive ergonomics** in understanding human-machine interactions and how the evolution of HCI led to new stages such as groupware, collaborative work, and social networks. The cognitive approach gave birth to an organizational point of view with the introduction of groupware and collaborative work, and the advent of the World Wide Web established a drastic practice change in modern societies, making humans **informavores**. The article underscores how the Web has become the **Semantic Web**, adding the intelligence of a universal librarian and how HCI cooperated with AI to optimize and adapt information search to users.

2.3 Intelligent User Interfaces

This section discusses the field of **Intelligent User Interfaces** (IUI) which is at the **intersection of human-system interaction, cognitive sciences, and artificial intelligence**. The IUI is defined as interfaces that provide tools to help minimize the cognitive distance between the mental model of the user and the way the task is presented by the computer, designed to improve the efficiency, effectiveness, and naturalness of human-computer interaction. The field covers different sub-disciplines such as computer vision, automatic language processing, knowledge representation, reasoning, and more. The article further explains that IUIs provide solutions in relation to different criteria for human-system interaction and need to take into account several models to cover perception, cognition, and action. The article concludes by stating that many approaches contributing to IUI can be found in the literature and provides some references for further reading, including **adaptive approaches** (adaptation of the interface to the user's needs and preferences), **model-based approaches** (creating a model of the user, the task, and the environment to support interaction), **agent-based approaches** (creating intelligent agents that interact with the user), and **cognitive architectures** (model the cognitive processes involved in interaction).

2.4 Affective Embodied Conversational Agents

This section discusses the concept of **Embodied Conversational Agents** (ECA), which are animated or human-like **virtual characters** used to interact with humans in a natural way. ECAs embody cognitive agents, interactive agents, and expressive agents, which are essential to design an ECA to improve the interaction. The cognitive dimension of an ECA means a representation of knowledge and a capacity to reason on them, while the interactive dimension refers to an agent's ability to interact in a multimodal way with a user. The **expressive dimension** of an ECA enables it to show, through verbal and non-verbal behavior, a particular cognitive and affective mental state. The article further discusses how emotions impact the behavior of an ECA and how they may be used to determine the appropriate behavior of the agent in a virtual environment. In the interaction with the user, the emotional knowledge of the agent should be enriched given the progress of the interaction, and the system to automatically recognize emotions is generally constructed on offline learning of the non-verbal, verbal, or physiological characteristics of emotions based on real or acted corpus of data of individual feeling or expressing emotions.

2.5 Consolidating, formalizing and exploiting usability knowledge for designing and evaluating interactive systems

This section discusses the efforts to **formalize usability knowledge** for designing and evaluating interactive systems. The goal is to integrate usability knowledge into a computational framework that can express, assess, and fix any potential usability problem detected at a high level of abstraction. Different methods and techniques for specifying an interactive system largely vary depending on their perspective, such as **psycho-ergonomic**, **Engineering of Interactive Computing Systems** (EICS), and **software engineering**. Model-based methods have been used for designing user interfaces, where a structured development life cycle is induced by the models. The **Cameleon Reference Framework** (CRF) has four levels of abstraction that structure this development life cycle. For the evaluation of interactive systems, many methods, techniques, and software exist to offer ample possibilities depending on the availability of the user interface and real users. Creating and manipulating the knowledge bases containing the usability knowledge required for the knowledge-based approaches for design and evaluation is critical. **Usability** and **accessibility** guidelines are a valuable source for supporting the (semi-)automated detection of potential usability/accessibility problems for designing as well as for evaluating. Five categories of usability guidelines could be distinguished: **design standards**, **usability principles**, **usability guides**, **style guides**, and **algorithms** for the knowledge-based generation of user interfaces.

2.6 Visualisation and data mining

This section describes the **importance of data processing and mining** in both research and industry. It explains that data can be **massive, complex, and non-structured**, making it difficult to discover new insights. Data mining uses algorithms to identify structural patterns that can be expressed as association rules, for example. The section provides examples of how organizations can benefit from data mining, such as refining marketing strategies or better understanding consumer habits. **Visualization** plays a crucial role in discovering patterns from data by proposing users with graphical representations that can be interactively manipulated and queried. The section highlights that **visualization is a high-level cognitive process**, and controlled experiments can **hardly validate techniques** that favor knowledge discovery. Instead, **best practices** and **design principles** are more convenient ways to evaluate visualization techniques. The article concludes that **human intelligence is crucial** in the data-foraging process, and Visual Analytics aims at knowledge discovery.

2.7 Conclusion

The conclusion of the article provides an overview of the **cross-fertilization** between HCI and AI in various research areas that was seen in the previous sections. The authors mention that significant work combining intelligence and interactivity in the aeronautical field started 40 years ago and is now continuing in different areas such as **simulation, semantic web, e-commerce, social networks, complex dynamic systems,** and **ambient intelligence**. The authors emphasize the promising prospects of smart user interfaces and affective embodied conversational agents. They also mention that ergonomic knowledge for the design and evaluation of interactive systems has been the subject of many studies since the early 1980s and will continue to be so in the future. Additionally, the authors highlight the close ties between visualization and data mining, which are representative of areas where HCI and AI join naturally. The authors conclude that the potential of cross-fertilization between HCI and AI continues to be a huge endeavor.

2.8 Overall conclusion of the article

In summary, the article provides a comprehensive overview of the intersection between Human-Computer Interaction (HCI) and Artificial Intelligence (AI). The article covers a wide range of topics, including intelligent user interfaces, affective computing, intelligent tutoring systems, and visualization and data mining.

One key takeaway is that the cross-fertilization between HCI and AI has been ongoing for over forty years, with significant work in aeronautics, simulation, e-commerce, social networks, and other fields. The complementary nature of HCI and AI has enabled the development of multifaceted domains, such as smart user interfaces and affective embodied conversational agents.

Additionally, the article highlights the importance of capitalizing, formalizing, and operationalizing ergonomic knowledge for designing and evaluating interactive systems. The potential for cross-fertilization between HCI and AI is enormous, and the integration of these two fields is likely to continue to be a significant endeavor for many years to come.

Finally, the article emphasizes the natural joining of HCI and AI in areas such as visualization and data mining, which offer promising opportunities for the development of new tools and technologies. Overall, the article demonstrates that the intersection of HCI and AI is a rich and constantly evolving area of research that has significant implications for the future of technology and human-computer interaction.

3 Second exercise

The second exercise for this week is the following:

> *Imagine an innovative adaptive interactive system. First, describe its main objective in one sentence. Then, propose 7 adaptation criteria (including the adaptation to the age) and explain what could be automatically adapted for each criteria (for each criteria, two or three sentences could be sufficient).*
>
> *Total = 1 + 7* (2 or 3) sentences*

References

[1] Christophe Kolski, Guy Andre Boy, Guy Melançon, Magalie Ochs, and Jean Vanderdonckt. Cross-fertilisation between human-computer interaction and artificial intelligence. *A Guided Tour of Artificial Intelligence Research: Volume III: Interfaces and Applications of Artificial Intelligence*, pages 365–388, 2020.