HCI – Human *Centered* Interaction

Alessandra Sciutti[1] & Giulio Sandini[2]

1. Cognitive Architecture for Collaborative Technologies Unit, Istituto Italiano di Tecnologia
2. Robotics, Brain and Cognitive Sciences Unite, Istituto Italiano di Tecnologia

Abstract. *Future AI specialists should ideally be faced from the start of their career with the most critical challenge in developing technology designed for humans: the humans. The complexity of human cognition as a whole and of its social component in particular needs to be accounted for, if the developer aims at creating AI systems able to help and engage users effectively and for more than a few days. This entails knowing your challenge - or at least gathering enough instruments to know how to approach the problem in a constructive way or who to ask for help. In our proposal we suggest 5 topics that according to us should be part of any syllabus used for teaching HCI skills to designers of AI interactive systems - and potentially also for those adopted in the context of HRI. This would help developers in creating technology considerate of humans, respectful of our needs and intrinsically caring of our wellbeing in the interaction.*

HCI needs to put the human at its center. This does not imply only participatory design - although of course it is important - but rather acknowledging that when we are creating AI for interaction, the most complex issues to consider are related to the complexity of humans! For HCI to be efficient and effective it would need to understand and predict the unfolding of the interaction. This is almost an impossible task if the interaction involves a human, as anybody running experimental studies with human participants know well. So the main and yet unsolved challenge in HCI (and HRI) is that of having a correct - or at least a close enough approximation of a - model of the human, allowing for understanding and anticipation [1]. This implies that the syllabus should give a central relevance to this core challenge, providing a path for HCI students to understanding the role of the human side of HCI, what a human is in interaction. Toward this goal, according to us these aspects should be part of a HCI syllabus:

1) SHARED PERCEPTION: it would be relevant to clarify that we do no perceive the world as it is but rather our perception is heavily shaped by perceptual and cognitive biases. This implies that creating technology that perceives at the highest level of accuracy might not be the right path to follow to facilitate interaction. It could be worth dedicating part of the course to study basics of human perceptual processes, ideally touching up psychophysics (perceptual thresholds, multimodal Integration, the role of priors in perception), cognitive science (cognitive biases) and neuroscience (mental simulation, mirror neurons, vision circuits, …).
2) COGNITIVE ARCHITECTURE: For interactive AI to be effective in social context over longer stretches of time, it cannot be a one-trick pony. In this context, it becomes necessary to think from an architectural point of view, where the single skill represents the instantiation of one of the architecture processes [2]. This does not refer per se to the software structure, but rather to the actual architecture of the cognitive system, as cognition is necessary to sustain interaction beyond the single, individual skill. Reading gaze direction or collecting user preferences is short lived if information are kept isolated and do not become the input of a complete system endowed with memory, perception, simulation and learning. Having an architectural vision gives the AI researcher the much-needed big picture to allow for a deeper understanding of how the single abilities are integrated, which skills are missing and how the whole system would be much more of the sum of its parts. An introduction to cognitive architectures – what exists, what is missing, which are the open challenges, would help acquire a vision guiding then the future developments and design.
3) **EMBODIMENT**: The relationship between AI and Robotics would need to be object of discussion. Embodiment has for sure a significant impact on human perception of AI. Several evidence point to measurable changes in the interaction with disembodied vs. embodied artificial agents, both in terms of trust, engagement and commitment and in quantitative performances (e.g., in education [3]). However, embodiment has an even bigger impact on the AI itself irrespective of the fact that the interaction is physically grounded or virtual. Interaction can change cognition, and interaction depends on how the agent acts and senses the environment and even virtual agents interacting with humans need to perceive and interpret human behavior. If it does it through a body and if it can change the environment through its actions, even the concepts, the representations it will build will depend on this. A staircase will fit in the “passage” general

category for a human, similarly as a door, whereas it would fit within the "obstacle" category for a wheeled robot. A course should delve into the implications of endowing an AI with a body and should discuss which differences and similarities might exist between HRI and HCI.

4) **DEVELOPMENT AND GROWTH (aging, dynamic evolution):** Helpful insights for HCI and AI in general can derive from human development as an example of how an intelligent system adapts to the changes of its sensing, motor and cognitive abilities. Human cognition often represents the benchmark with which to compare AI systems, and human-level cognition would be a desirable target in several HCI applications. However, human cognition is extremely complex and derives from the ability to learn and adapt through experience and through the interaction with the environment and with others. The cognitive abilities exhibited by human adults, however, might not be the most accessible entry point to unveil what supports the dynamics of human cognition. In fact, development gives a unique opportunity to explain how state depends crucially on the history of previous states and how previously acquired skills mediate the acquisition of more sophisticated and adaptable ones. As with planking during the construction of a new building, the sequence of the layers is determinant in shaping the result, but some of the layers are only temporary and are not visible in the final product (once you have learned how to write, it is impossible to describe introspectively the sensorimotor strategies adopted). Guiding the students to understand how cognitive and interactive skills develop from birth to adulthood could provide a new perspective on the challenges of HCI. For instance, it could suggest new approaches to segmenting the problem in progressively increasing challenges (and system abilities).

5) TRANSDISCIPLINARITY: HCI necessitates an open discussion among a wide range of different disciplines, which goes beyond the traditional boundaries that see humanities, visual and performing arts and journalism as completely detached from robotics and engineering. Indeed, artistic activities are much more effective in capturing the essence of being human (as emotion expression in paintings, poetry and dance) than any robotic platform. The syllabus should somehow reflect the need to interface with these other domains to achieve a kind of HCI where the emphasis is more on the H that on the C. A possible first step toward this direction could be acknowledging different types of HCI. The HRI community has done something similar starting in 2015 in the HRI conference proposing different submission categories: 1) Studies of Human-Robot Interaction (i.e., studies of interaction with prototype or deployed robot systems); 2) Enabling Technologies (i.e., technologies that facilitate new forms of interaction); 3) Enabling Designs (i.e., designs that promote new forms of interaction); 4) Enabling Methods (i.e., methods that make new forms of interaction or HRI research possible); 5) Enabling Knowledge (i.e., knowledge that informs future HRI design or HRI research)[1]. This way it became clear that HCI could have a strong engineering component, but also a philosophical component for instance, and both had equal right in receiving an appropriate assessment.

We believe that the consideration of these five elements in a syllabus for HCI would foster a training apt at preparing the student to deal with many of the complex components at the basis of such a fascinating and complex topic.

References

[1] A. Sciutti, M. Mara, V. Tagliasco, and G. Sandini, "Humanizing human-robot interaction: On the importance of mutual understanding," *IEEE Technol. Soc. Mag.*, vol. 37, no. 1, 2018.

[2] D. Vernon, *Artificial Cognitive Systems*. Cambridge: MIT Press, 2014.

[3] T. Belpaeme, J. Kennedy, A. Ramachandran, B. Scassellati, and F. Tanaka, "Social robots for education: A review," *Science Robotics*. 2018.

Acknowledgment

A.S is supported by a Starting Grant from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme. G.A. No 804388, wHiSPER"

[1] http://humanrobotinteraction.org/2015/themes/index.html