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Animal-Computer Interaction (ACI): A Manifesto

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ABSTRACT: Although we have involved animals in machine and computer interactions for a long time, their perspective has seldom driven the design of interactive technology meant for them and animal-computer interaction is yet to enter mainstream user-computer interaction research. This lack of animal perspective can have negative effects on animal users and on the purposes for which animal technology is developed. Not only could an Animal-Computer Interaction (ACI) agenda mitigate those effects, it could also yield multiple benefits, by enhancing our inter-species relationships with the animals we live or work with, leading to further insights into animal cognition, rendering conservation efforts more effective, improving the economical and ethical sustainability of food production, expanding the horizon of user-computer interaction research altogether and benefiting different groups of human users too. Advances in both our understanding of animal cognition and computing technology make the development of ACI as a discipline both possible and timely, while pressing environmental, economical and cultural changes make it necessary. But what exactly is ACI about and how could we develop such a discipline? This Manifesto describes the scientific aims, methodological approach and ethical principles of ACI and proposes a research agenda for its systematic development.

A Long History

Animals[1] have been involved in machine interactions for many decades. For example, Skinner's famous operant conditioning chamber, used in behavioural experiments since the early '30s[12], provided output devices such as lights or sounds, input devices such as levers or buttons, and other output or feedback mechanisms dispensing food or water, if say a rat or pigeon completed given sequence tasks correctly. These systems have gradually evolved into sophisticated computerised environments affording complex interactivity. Other interaction systems such as computer games currently employed in more advanced primate cognition studies provide, for example, on-screen animations that can be controlled via joystick[13].

Within agricultural engineering, interactive computing devices have also been developed, for example, to optimise milk production in farming industry, with the introduction of the first automatic milking systems in dairy farms in the early '90s[15]. These systems have rapidly developed into cutting edge applications of pervasive and ubiquitous computing technology, enabling cows to independently engage in voluntary milking and express intelligent and social behaviour never previously observed in constraining farming environments[17].

Examples of a different kind of interaction are provided by tracking and telemetric sensor devices, which have been used in conservation studies since the early '70s and which have now become commonplace. For example, radio-collars allowed researchers to uncover the elusive behaviour and territorial needs of snow leopards for the first time[9], and satellite collars enabled conservation efforts to start mapping the movements of elephants[10]. Moreover, telemetry is used in laboratory settings to monitor, for example, dogs' physiological parameters during pre-clinical trials[16].

In short, animal-computer interactions can be found in many areas in which human activity involves other species and have a long history behind.

The Elephant in the Room

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[1] The term animal(s) is loosely used throughout to refer to nonhuman animals.

In spite of their history, the study of the interactions between animals and computing technology has never entered mainstream computer science and the animal perspective has seldom informed the design of animal computing applications, whose development has so far been driven by academic disciplines other than computer science or by other industrial sectors. The design of these technologies remains fundamentally human-centred, and the study of how they are adopted by or affect their users remains fundamentally outside the remit of user-computer interaction research.

The negative effects of this lack of animal perspective become obvious when, for example, the behaviour and welfare of seals fitted with bio-logging tags and satellite transmitters are significantly affected, and data gathered during costly conservation studies risks invalidation[6]; or when cows who do not engage with milking systems are culled and farmers suffer capital losses[17]. But risk mitigation aside, what about the things that we could gain from a shift in perspective? What would it allow us to learn about and achieve with interactive technology? How would it influence our reflection on usability, adaptation, appropriation, methodology, ethics, to name but a few aspects?

Thankfully, a few studies into domestic canine and feline computer interaction have started making an appearance at HCI venues[11,18], but the remarkably marginal position that this research still occupies in this community is an indicator of the fact that its significance has not yet been recognised. For some reason, Animal-Computer Interaction is, quite literally, the elephant in the room of user-computer interaction research. Perhaps the time has come to acknowledge the elephant, to start talking about ACI as a discipline in its own right and to start working towards its systematic development.

The Right Moment

Advances in our understanding of animal and comparative cognition, and in computing technology make the development of Animal-Computer Interaction as a discipline both possible and timely.

Since we have trained them to do so for a long time, of course, we know that several species can use interactive devices of one kind or another, sometimes appropriating them in interesting and unexpected ways. More generally, though, we now know that many species have sensory faculties superior to ours[19], possess sophisticated cognitive abilities, engage in advanced problem-solving, use purpose built tools for complex tasks[4], communicate through articulated languages, experience a range of emotions, form complex social relationships, make moral judgements[2], and hand down cultures through generations[14]. This has progressively made us more aware of the similarities between humans and other species, more appreciative of other species, and more attentive towards the significance of our relationships with them and the environment we all share[8].

At the same time, the interaction modes afforded by computing technology have expanded well beyond those provided by keyboard and mouse. Tangible, embodied[7] and proxemic[5] interactions, for example, have brought physicality back into computing by engaging the whole body through contact and movement. Sensor technology has become more agile, robust and sensitive, better able to read the changes coming from within and around us[1]. In general, developments in pervasive, ubiquitous and ambient computing are enabling technology to adapt to our spontaneous behaviours and to the contexts that these continuously produce and modify. Not only do these advances make computing technology more accessible to humans, they make it far more accessible to other species too.

Aims and Approach

ACI aims to understand the interaction between animals and computing technology within the contexts in which the animals habitually live, are active and socialise with members of the same or other species, including humans. Contexts, activities and relationships will differ considerably between species, and between wild, domestic, working, farm or laboratory animals. In each

particular case, the interplay between animal, technology, and contextual elements is of interest to the ACI researcher.

ACI aims to influence the development of interactive technology to:

- Improve animals' life expectancy and quality, by facilitating the fulfilment of their physiological and psychological needs; for example, technology that promotes healthy feeding habits in pets or provides them with entertainment is consistent with this aim;

- Support animals in the legal functions they are involved in, by minimising any negative effects and maximising any positive effects of those functions on the animals' life expectancy and quality; for example, technology that gives farm animals control over the processes they are involved in, lowering their stress levels and enabling them to express more natural behaviour, is consistent with this aim;

- Foster the relationship between humans and animals, by enabling communication and promoting understanding between the two; for example, technology that enabled guardians to understand and respond to the emotions of their companion animals is consistent with this aim.

ACI aims to develop a user-centred approach, informed by the best available knowledge of animals' needs and preferences, to the design of technology that is meant for animal use. It also appropriately regards humans and other species alike as legitimate stakeholders throughout all the phases of the development process.

Ethical Principles

ACI takes a non-speciesist[3] approach to research and researchers have a responsibility to:

- Acknowledge and respect the characteristics of all species participating in the research without discriminating against any of them.

- Treat both human and nonhuman participants as individuals equally deserving of consideration, respect and care according to their needs.

- Choose to work with a species only if the intent is to advance knowledge or develop technology that is beneficial or otherwise relevant to that particular species.

- Protect both human and nonhuman participants from physiological or psychological harm at all times, by employing research methods that are non-invasive, non-oppressive and non-depriving.

- Afford both human and nonhuman participants the possibility to withdraw from the interaction at any time, either temporarily or permanently.

- Obtain informed consent to the involvement of both human and animal participants, either from the participants themselves (e.g., for adult humans) or from those who are legally responsible for them (e.g., for animals).

Widespread Benefits

The development of ACI as a discipline could have many benefits. For example, it could have important effects on our inter-species relationships by informing the design of technology that enables the animals we live and sometimes work with to effectively communicate with us, increase their participation in our interactions and constructively influence our environments, giving us a better understanding of those we share our lives with and the possibility to build better, longer and more productive relationships with them.

ACI could also lead to further insights into animal cognition, for example, by informing the design of interactive technology for behavioural studies that affords optimal usability and creative appropriation for the animals. Or it could support conservation efforts, for example, by informing the design of monitoring devices that produce minimal impact on the animals while maximising the quality and reliability of the data gathered through them.

Moreover, ACI could improve the economic and ethical sustainability of food production, for example, by informing the design of technology that affords farm animals more freedom and autonomy, enabling them to live less unnatural lives, reducing their stress levels and susceptibility to illness without recourse to drugs, increasing their productivity and improving the quality of their produce.

Finally, ACI could expand the horizon of user-computer interaction research by pushing our imagination beyond the boundaries of human-computer interaction. For example, it could help us discover new ways of eliciting requirements from those who cannot communicate with us through natural language or abstract conceptualisations. It could help us explore new modes of interaction for those who do not possess hands, cannot decipher the patterns emitted by a screen or have limited attention spans. Or it could help us find new ways of understanding and evaluating the impact of technology on individuals and social groups, perhaps shading new light on issues such as identity, privacy or trust, and contributing to our understanding of what it means to be human and who we are in relation to other species.

A Research Agenda

Of course, whether ACI can yield the benefits outlined above depends on our ability to tackle some challenging questions. For example, how do we elicit requirements from a nonhuman participant? How do we involve them in the design process? How do we evaluate the technology we develop for them? How do we investigate the interplay between nonhuman participants, technology and contextual factors? In other words, how on earth are we going to develop a user-centred design process for animals? Here is a possible roadmap:

- First, we could look at what has been done in other areas, what knowledge about animal behaviour and psychology is available, what data has already been collected about animal-computer interactions. We could look at how all that maps onto what we know about user-computer interactions and how it might contribute to ACI as a discipline and design practice.

- Second, we could form collaborations with researchers from disciplines such as ethology, behavioural medicine, animal psychology, veterinary, agricultural and environmental engineering to help us with this mapping effort. Similarly, the expertise and experience of professionals and practitioners who work with animals in environments where animal-computer interactions take place would be important.

- Third, we could study in-the-wild cases of whatever technology is already in use or might be developed in order to understand those domains and contexts, their users and stakeholders, so that we can begin to develop or adapt relevant ACI concepts and models.

- Fourth, we could look at human-centred interaction design protocols and methods in order to assess which may or may not be relevant to an animal-centred design process, which might be adapted, which might be borrowed from other disciplines, and which might need to be developed from scratch.

- Fifth, we could start adapting, developing and integrating animal-centred interaction design protocols and methods, for example, for requirements elicitation, participatory design, contextual evaluation, etc., in a loop between empirical work and theoretical reflection.

- Sixth, we could start developing theoretical models of animal-computer interaction, which would then drive further research. These would take into account pre-ACI research on animals and would be informed by ACI empirical research with animals.

An Invitation

Because of the questions it raises and the challenges it poses, ACI is arguably the next frontier in the study and development of interactive technology. Those who are keen on joining in the

exploration of this new territory are warmly invited to sign the ACI Manifesto and join our Animal-Computer Interaction group at: http://www.open.ac.uk/blogs/ACI/

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