Critical Realist HCI

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Abstract
Against the backdrop of the current debate about HCI's relationship with science and its ways to produce and argue for knowledge, this paper seeks to develop a novel philosophical foundation that rests on the central ideas put forward in *critical realism.* While it affords many of the features of the post-modern theories that shaped modern HCI, critical realism avoids the danger of slipping into extreme relativism, in which knowledge construction becomes arbitrary and isolated in its context. Moreover, critical realism is inherently multi-faceted and provides a basis on which scientific enquiries of very different natures can be treated complementary rather than as competing with each other. This allows us to develop a non-reductionist view on interaction with technology that accommodates and potentially reconciles the variety of approaches, practices and stances that we see in current HCI.

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philosophy of science; knowledge production; critical realism

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Introduction

There has been a fresh wave of soul searching within HCI with respect to the field's relationship to science and its nature as a community. This discussion unfolds along multiple, interwoven threads: one is defining HCI as a scientific discipline that has sustainable and stable practices and foci. Here, Liu et al. have quantified what many have suspected, that HCI is a very heterogeneous field of research that lacks what the authors call motor themes – well defined, mainstream topics that attract sustained attention by large parts of the community [18]. While the diagnosis is undisputed, the conclusions are less so. Blackwell disagreed with Liu et al.'s call to rally behind motor themes and offered to reframe HCI as an inter-discipline [2]. While Blackwell's analysis of HCI projects from the Crucible network of the University of Cambridge is confirming that there is indeed a lack of convergence, he concludes that it is the identifying character of HCI to be defined through its relationship with other disciplines. It thus does not produce a stable body of knowledge in the sense of traditional sciences, but is a catalyst for innovation in collaborations.

Investigating historical influences on HCI, mainly provided by cognitive sciences, Reeves arrives at a similar conclusion [20]. He suggests that the community should pragmatically "stop worrying about 'being scientific' ", but instead develop appropriate forms of rigour and embrace the idea of being interdisciplinary, rather than a discipline by itself. He argues that the model of natural sciences does not match up with the lived material practices of (natural) scientists and that consequently, trying to adopt this model for HCI, with its formal accounts, "seems weak and potentially confusing". By highlighting "appropriate rigour" instead of "being scientific", Reeves divorces the two terms, pointing to the need for a non-reductive account that reconciles different, disciplinary conceptions of rigour which run counter to the traditional ordering of sciences.

While Reeves avoids talking directly about knowledge in his work above, the epistemology of HCI is another prominent thread in the overall debate about the field's standing. Much of the relationship to the sciences is defined by the ways knowledge is produced and argued for, which of course in turn is interwoven with the concept of rigour. In 2015, Höök et al. organised a workshop at the CHI conference about knowledge production in interaction design [15]. The organisers argued that knowledge comes in various forms, ranging from universal laws to highly contextualised insights. In between, forms of "intermediary knowledge", such as strong concepts or annotated portfolios have gained popularity and are increasingly used to communicate research through design outcomes. In an article that captures the outcomes from this workshop, the authors describe an agenda for increasing legitimisation of such intermediary knowledge, which resonates with Reeves' argument about appropriate rigour. In order to increase the standing of these different kinds of knowledge, we need to find their "symptoms of excellence" and communicate them within the community and the intended audience, e.g. the broader scientific community [14].

Many of these threads can be traced back to when HCI picked up on the works of Kuhn [16], Rittel and Weber [21], Schön [23], Suchman [24], Cross [4] and many others. What Harrison et al. describes as the *third paradigm of HCI* [12], could be said to be HCI's entry into the postmodern world. However, while the shift was initially born out of a pragmatic need to overcome the limitations of prior paradigms to describe socio-technical problems, it soon became clear that the epistemological implications destabilised the "scientific" foundations on which HCI built its tradition [11]. In what might be a typical reaction in any

research field, the response was mainly methodological, shifting towards designerly practices and positioning design as a method of scientific enquiry – Research through Design (RtD). The ensuing debate around what we are to expect from RtD in terms of being scientific, accountable, rigorous, generative, descriptive, predictive etc. [9, 27, 7], demonstrates that this did little to calm the epistemological trouble.

At this point of the debate, the contribution this paper seeks to make is to develop an alternative philosophical foundation for HCI as a science in order to re-frame some of the dilemmas and apparent dichotomies that seem to define current discussions. Inspired by critical realism, a philosophy of science mainly developed by the British philosopher Roy Bhaskar, I investigate how central themes and practices in contemporary HCI react to being viewed through an alternative meta-physical position. The aim is **not** to prematurely call for a paradigm shift in HCI or stir up a new wave, but more modestly to highlight possible ways to reconcile the many practices, theories and underlying philosophical stances that are generally believed to be HCI, in a multifaceted, but conceptually coherent way.

The following section introduces the main ideas behind critical realism as a philosophy of science and its positions compared to other mainstream belief systems. Subsequently, I take a critical realist view on some of the main themes in the current HCI discourse, including situatedness & context, the social & embodiment and different ways of knowing. I follow with a discussion on the concept of experiments and how the critical realist understanding of experiments might enable HCI to make its many constituent practices meaningfully intertwined and complementary. I close with a reflection on how these thoughts connect with the discourse laid out above and point to future work.

Critical Realism

Critical realism is a philosophy of science that was predominately shaped by the British philosopher Roy Bhaskar. He initially used the terms transcendental realism and critical naturalism to describe his ideas, but eventually those were shortened into the now widely used term “critical realism” [3]. Like any philosophy of science, critical realism is concerned about what is (ontology) and how we can know about it (epistemology). And like the variety of post-modern philosophies, it has developed as a reaction to the empiricist, more specifically the positivistic philosophy or practice of science that has so significantly shaped, and in many ways still is shaping, our understanding of what “doing science” means. However, while they share some features, critical realism and post-modern thought arrived at quite different standpoints.

A common point of departure for both lines of thought was to reject the (post-)positivistic idea that there is an absolute truth about reality that we can find out about in an empirical way. Particularly in the social sciences, there was growing recognition that we cannot know about people in the same way that we can know about atoms. In what became known as the “linguistic turn”, the post-modernist answer is that understanding social reality is much more *“akin to understanding a language than a machine”* ([19], p8), i.e., it is irreducibly complex, situated, socially constructed and interpreted. Reading Kuhn’s work about scientific traditions and revolutions [16] in a post-modern way, quickly expands this argument to the natural sciences: ultimately all we accept as scientific knowledge can be seen as constructed by social agents within their respective cultures. However, continuing this line of argument further, leads into relativism with problematic consequences for scientific progress. If reality is entirely constructed, who is to say what is right and what is wrong? And can we still decide an argument

about contradictory knowledge originating from different science processes? Relativism poses the threat that any (scientific) progress is reduced to an arbitrary variation of a constructed reality.

Critical realism rejects this notion and starts ontologically with a quite different position: there exists a reality that is independent of our description. However, it also rejects positivism for reducing reality to what can be empirically known. Positivism infers the actual from the empirical (actualism, see [3], p7) and thereby reduces things to observable causal events and generates knowledge by generalising invariances in these causal relationships. Critical realism argues that this is not exhaustive and that things have potentiality and mechanisms that might not have been realised ([3], p7). It focuses on the underlying structure rather than the observable surface. This also allows it to see "things" as a broader category, they maybe powers, forces or relations[1]. *"Things possess characteristics which have tendencies to interact in particular ways with other things"* ([19], p11). These tendencies are not invariant, but are better understood as properties of mechanisms of which we can know of to a certain degree. Reality, thus, exists of things that interact through mechanisms which have certain tendencies. These real things are *intransitive objects*, and humans aim to understand the nature of the real mechanisms that connect them. Their understanding of these mechanisms is fallible, interpretative and socially constructed, and hence their models and theories are *transitive objects*. Scientific progress, therefore, becomes improving one's transitive objects, and (re)building these requires more than empiricism, but human reasoning on multiple levels.

What seems, in this philosophical debate, to be splitting hairs, has some significant ramifications for the practice of science. In the following I take a critical realist perspective on human-computer interaction as a scientific field defined by the aim to understand and design the roles of interactive technologies in our social world. I do so along central themes that have emerged from the latest paradigm shift in HCI [12].

Situatedness & Context

Arguably, one of the most central themes in modern HCI research is its recognition of context. Numerous contributions to the field have argued that interactions with technology cannot be studied or understood in a de-contextualised manner (e.g., [5]), most prominently building on Suchman's concept of situated actions [24]. Suchman dispels the human-factors' notion of actions being a consequence of rational plans, but emphasises that humans act within their circumstances. As a consequence, HCI methods evolved that borrowed from ethnography, ethnomethodology and anthropology to understand the *Who?, What?, How?* and *Where?* of interaction to inform design. Popular, mainly qualitative approaches include Contextual Inquiry [13] or Cultural Probes [8].

Critical realism too is acutely aware of the importance of context. It is reflected in the notion of *open and closed systems* in which things interact ([3], p33). In open systems, i.e., the world we live in, many different things and mechanisms exist and understanding one mechanism has limited predictive power for how things play out in the wild. It is the emphasis on understanding the underlying mechanisms through which things interact that offers new perspectives on context. For example, it allows for potentiality of things which takes us beyond what could be empirically determined about a context: constellations that never were observable because some behaviours of things were un-

[1] Exactly what things are and what their causal powers would be, is a central debate within critical realism ([19], p22 ff.)

realised, can be considered in the design, because we have gained some understanding of the mechanisms that produce these behaviours. Such "hidden" properties in context are only possible when we accept that reality cannot be reduced to its social determinants.

With its focus on how things work, critical realism has some parallels with ethnomethodology, which seeks to explain the methods people use to produce their social life. A critical realist interpretation, talking about things and mechanisms, implies a wider scope however. Critical realism, it seems, allows hybrid networks in a similar fashion as Actor-Network Theory (ANT) advocates [17]. While ontologically, the two, ANT and critical realism, seem to be incommensurate, they share a fundamental notion of describing situated interaction through relationships of entities that can be human and non-human. HCI research, then, is concerned about describing and designing the mechanisms through which humans and technologies interact in a hybrid, open network.

In contrast to ANT, critical realism does draw a sharp line towards relativism and thereby protects the insights it produces from completely dissolving in its context. If everything is constructed and determined by the particular context, then there is nothing knowable that could possibly inform the design of technology. However, if we accept that we have an, albeit limited, idea about the characteristics and tendencies of real things that interact, we might be able to use this knowledge to design new things and mechanisms (e.g., technologies) and can have an informed guess about how the whole network reacts. In many ways, I argue this is what critical design does: it introduces things and mechanisms with the aim to make the network react in anormative ways, so that critical alternatives and potentiality becomes visible [1].

The Social & Embodiment

While context in the above sense could be interpreted as something external or separate to the human actors, HCI has gone a step further and embraced a phenomenological view that emphasises that the social and physical context is deeply interwoven with humans and their situated actions—they are embodied by them. Building on the philosophy of Heidegger and Merleau-Ponty, but also Gibson, HCI thinkers such as Winograd and Flores [26], and Dourish [5] have developed a theoretical starting point for describing how we interact with, and more importantly through, technology that is part of the social and physical fabric that we are made of. For example, social networks can be described as seamlessly extending our life-worlds and the tools we use, e.g., mobile phone apps, become embodied in our actions in the same sense as an Heideggerian tool. All this has led HCI to move increasingly "into the wild" [22], looking towards alternative ways of understanding, designing and evaluating the role of technology.

While phenomenology is concerned about how we are in our world through how we experience it, I argue, it is possible to read it in a critical realist way. While "things" in the critical realist framework are seen as separate (i.e., real, intransitive) to what we can know about them (transitive), the emphasis on them acting through the mechanism that they embody provides a bridge to phenomenology. As stated above, things are not restricted to physical objects, but can be structures, concepts or ideas and the complex interplay of their mechanisms makes up reality. It can be argued, that central phenomenological concepts such as intentionality or intersubjectivity can be explained through the interplay of mechanisms. Intentional objects are, then, available to human consciousness by offering specific mechanisms for interaction. For example, our conception of mobile phones might be dominated by its mechanisms to connect us to a

social network while for other purposes, our intentionality directs us to punch numbers into it through another aspect of its mechanism. Phenomenological intersubjectivity aims to explain how we can know about other humans and the Heideggerian view is that our shared Being-in-the-world and our engagement with this world allows us to develop empathic understanding about others [6]. Again, a critical realist interpretation might lead us to describe this as an interaction between "things" such as social structures and human actors that give us the leverage to know about others. As everyday life shows us, this knowledge is inherently fallible, but this too can be explained by the transitive nature of our knowledge about the mechanisms by which these "things" interact.

This, of course, is an overly crude and very preliminary sketch of a critical realist view on phenomenology. However, understanding social structure or embodiment as real things that have certain mechanisms through which they become available to other real things, human actors, also makes them available for scientific investigation. To recognise that these relations are mechanisms is to say that there are interactions that are ordered and structured and thus are something that we can know about, if we could find the appropriate scientific methods to investigate them. In principle, this is Roy Bhaskar's counter-argument to the hermeneutic's view that social phenomena cannot be the subject of the same science as natural phenomena which, in the extreme, leads to the relativism inherent in extreme forms of social constructionism.

Different ways of knowing

Epistemology has been the main battle ground on which paradigm shifts have been argued. Traditionally an engineering discipline, HCI was firmly in the hands of positivists implementing an empiricist agenda by seeking causal relationships through identifying significant patterns in observable data. As outlined above, this reduces the question to what exists to what can be measured and is in many ways inadequate, not only for the social sciences. HCI has consequently embarked on a transformation, which I would argue is still ongoing, to redefine the way it describes and creates technologies that humans can interact with [12]. In this transformation, the question of how we can know things has been made central with one side questioning the rigour and significance of results from situated studies, while the other side calls into question the real-world relevance of highly controlled studies and their insights—a, in my view misguided *rigorous-or-relevant* dichotomy. Being quite literally on the interface between natural and social sciences, HCI finds itself caught in the historical debate about the possibility of "naturalism" in the social sciences, initiated by the interpretivist or hermeneutic tradition. The field of HCI, thus, now is home to very different epistemological positions ranging from classical empiricism to pragmatism to pure, social constructivism, depending on which stance researchers or practitioners choose to take.

A critical realism perspective offers to potentially resolve the *rigorous-or-relevant* dichotomy. To be *relevant*, knowledge produced by HCI has to relate to everyday life and thus acknowledge the openness and uncontrollability of the system as well as the fallibility of the process of enquiry. Equally, though, enquiries have to be *rigorous*, or in other words, we need to be able to say that our understanding about something has improved by doing science and that we can build on this understanding in future work. Extreme positions in social constructivism make this nearly impossible as no knowledge can be "better" or "truer" in its social construction and consequently, improving our understanding becomes arbitrary. In HCI we can observe this phenomenon, when insights dissolve in the specifics of the context stud-

ied, i.e. they can be re-constructed in any other way given any other context.

Key to the critical realist attempt to overcome this dichotomy and do *rigourous-and-relevant* science is the re-conceptualising of experiments.

Experiments in HCI

The concept of experiments is central to the philosophy of science Roy Bhaskar put forward. Its interpretation, however, is quite different to what traditionally would be associated with it. It differentiates open and closed system in which experiments are conducted. While closure, in this context, is similar to the conditions a controlled study would seek, critical realism acknowledges that closure is not natural and that the actual behaviour of the thing under examination is determined by the interplay of many mechanisms in the real world, an inherently open system. But it is precisely because we create unnatural conditions, we are able to learn something and better understand a certain aspect of a real thing. What we discover are *tendencies* of mechanisms which are the causal powers of real things. These tendencies are more than statistical probabilities as they relate to things and mechanisms rather than to a sequence of events. In contrast to empiricism, this understanding does not hinge on the pretended objectivity of observable data, but recognises human reason as a central tool to produce knowledge about mechanisms.

It follows from this position that critical realism fully acknowledges the fallibility of the knowledge as it is produced by humans and might be subjected to ideological, economic or political biases etc. This is a sort of *epistemic relativism* in contrast to the ontological relativism inherent in social constructionism. Crucially, however, critical realism maintains that by conducting good experiments, we can improve our understanding of the mechanisms that produce the behaviour of real things, i.e., we can objectively argue for a better understanding of reality. For example, if we know that people tend to use their mobile phones in public transport, we can imagine devising experiments that allow us to improve our understanding about the mechanisms involved and maybe find that these tendencies are related to having little else to do in a socially non-committal environment. These statements are not highly predictive for future actions, a claim positivists would like to make, however, this does not render the explanatory nature of the knowledge useless for creating new design, for example.

The above example can also help demonstrate another central concept in critical realism: the *stratification* of knowledge ([3], p49)). If we accept that in open systems a multiplicity of mechanisms determine the course of real things and that experiments can help us to understand the tendencies of some of these mechanisms to a better degree, then we can also see that some mechanisms build on others in an ordered way; in the same way as our understanding of drugs builds on that of chemical reactions which builds on that of atomic structures and so forth. Roy Bhaskar has called these layers of ordered mechanisms *strata*, with mechanisms on a lower stratum explaining others on a higher stratum without replacing them[2]. Consequently, we can think of doing science vertically or horizontally: we can seek to improve our understanding of mechanisms within one stratum or try to find others, more basic ones that help explain it. To apply this to the above example: we can identify one stratum that deals with high level motivations of people to communicate and the social dynamics in public

[2]Critical realism does not claim that lower strata can *fully* explain higher strata and would strongly reject atomism, i.e. it defends that the whole is more than the sum of its parts

transport. Another, more basic stratum would be to understand the affordances of technologies for communication and much further down a stratum would include Fitt's Law to contribute to our understanding about how people type on touch screens.

And it is precisely here that critical realism might be able to provide a basis on which we can resolve the *rigorous-or-relevant* dichotomy. If all mechanisms jointly determine the course of a stratified nature, we can argue that any deepening of our understanding of mechanisms on any stratum contributes to our understanding of what happens in the real world. Thus, highly situated studies on what makes people want to communicate while sitting on a train contribute to our understanding of reality as well as a highly controlled study on typing speeds in a usability lab, *as long as we put each mechanism into the perspective of the whole and relate it to the real thing*. We can now see how very different kinds of studies can enquire into the *same* reality on different strata. Each of them requires different methods and different ways of capturing and producing its knowledge contribution ([19], p13).

Discussion & Conclusions

The above is a first attempt to develop an alternative philosophical foundation for the science of HCI with the aim to reconcile the many practices, methodologies, theories and traditions in the field. A critical realist perspective on HCI is appealing, because it is non-reductionist, multi-faceted and dialectic, while offering notions of objectiveness, rigour and accountability. It responds in a different way to the discourse outlined in the introduction to this paper. While Köök et al. pragmatically look to increase the legitimisation of intermediary knowledge in HCI [15], the proposal here aims at the foundational level: if "universal laws" and highly contextual insights can live in a common, coherent scientific framework, intermediary knowledge is not merely fitting in between, but is another, equally valid facet of knowledge about the same reality. If those different kinds of knowledge are constructed on the same basis, then the issue is not to legitimise any of them, but to meaningfully relate them to each other. To exemplify, if Fitt's law and insights from cultural probes are treated as enquiring into the same reality, from different perspectives and on a different strata, the challenge becomes finding ways through which they become complementary rather than defining a spectrum of reliability.

This links in with Reeve's argument about rigour [20]. HCI has been very good in defining "symptoms of excellence" [14] in horizontal lines of research, e.g., we have become much better in identifying usability problems through eye-tracking methods in the lab or we have become much better in understanding user practices through probes. Design schools and UX Laboratories within themselves have their tried and tested rules to identify rigorous work, they are, however, not always compatible and the uncertainty about the quality of work emerges when one is scrutinised against the rules of another. A critical realist perspective draws attention to the fact that different kinds of knowledge produced on different strata represent facets of the same reality. We thus need to invest in producing vertical knowledge and its associated notions of rigorousness.

This perspective strengthens the case for Blackwell's framing of HCI as an inter-discipline [2]. What if HCI really is, at its core, about relating knowledge on different strata to paint an, albeit inherently incomplete, picture of a reality in order to understand through which mechanisms human and non-human things interact? Crucially, critical realism would suggest that it is the real thing that provides the anchor point for integrating different strata. This notion of the

centrality of things resonates with research through design. Wakkery et al., for example write about their contribution to "the increasing turn within interaction design and HCI research to develop forms of knowledge production centred on the essential role of designed artifacts" [25]. A critical realist perspective draws attention to the mechanisms through which a designed artefact interacts with other things in the real world. Of some of these mechanisms, we can learn about in (somewhat) closed experiments on lower strata. Of others, more complex ones, on higher strata, we can still learn by doing good experiments, but the knowledge produced is of a different kind. Centrally though, all mechanisms can be related to the situated artifact and thus, it becomes the starting point to meaningfully relate different kinds of knowledge.

As a philosophy of science, Critical Realism addresses two significant gaps in the existing philosophical foundations of HCI: firstly, it avoids relativism while remaining situated in context. While not all forms of constructivism, as the dominant epistemological stance in post-modernism and its application in HCI, lead to extreme relativism, it cannot completely shake relativism off either. The commitment of constructivism to a reality that is determined by the individual and the social discourse inevitably leads to a notion of truth, that is problematic in the scientific discourse as it is not possible to objectively improve one's understanding. When notions of objectivity are dissolved, then the refining, transferring or combining of knowledge becomes impossible.

Feminist thinker Donna Haraway, has articulated this problem of "...how to have simultaneously an account of radical historical contingency for all knowledge claims and knowing subjects, a critical practice for recognizing our own "semiotic technologies" for making meanings, *and* a no-nonsense commitment to faithful accounts of a "real"world.." [10]. She goes on to argue for a doctrine of feminist objectivity that emphasises partial knowledge and a situated, embodied and localised epistemology that is stitched together. Crucially, she rejects relativism and argues for rationality within the localised knowledge. Critical realism is compatible, I would argue, with this line of argument as it acknowledges the incompleteness of the knowledge we can have about the real world, while at the same time retaining a notion of objectivity that allows us to improve on our knowledge of it.

The second gap critical realism addresses, is the lack of common ground for integrating different kinds of scientific enquiries and their resulting knowledge claims. Accepting incomplete, possibly localised, knowledge as contributing towards an improved understanding of the same reality from different perspectives (possibly on different strata), presents an appealing opportunity to arrive at non-reductionist accounts and resonates with Haraway's metaphor of stitching together the knowing self [10]. Just how this stitching, this vertical integration of knowledge towards a better understanding can be practically achieved is the matter of future research. As argued above, using the physical artefact as an anchor seems to be a promising route as well as looking towards other approaches such as Actor-Network Theory or Activity Theory and their respective ways to deal with different kinds of knowledge.

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