International Journal of Computer Applications (0975 - 8887)
Volume 177 - No.18, November 2019

The Geometry of Information Retrieval is a Cybernetics, and it is to be Overcome

Sachi Arafat
King Abdulaziz University
Saudi Arabia

ABSTRACT

Our paper argues that the geometry of Information Retrieval (IR) is more akin to a cybernetics than it is a quantum theory. However, as a cybernetics, several aspects of IR as poorly captured. It provides some correspondence between IR and cybernetics, identifying the behaviourist character of the latter as the limiting issue and suggesting the need to recontextualise IR outside of any such discourse. It discusses the implications to some foundational notions, and to methodology in such a recontextualisation.

General Terms

Information Retrieval, Cybernetics, Foundations, Geometry

Keywords

Information Retrieval, Cybernetics, Quantum Theory, Geometry, Information, Foundations

1. INTRODUCTION

The seminal text in quantum theory inspired Information Retrieval (IR) [32] is aptly named as the Geometry of Information Retrieval. A geometry is typically an abstract representation of the material world in terms of shapes, their relative spatial-positions, orientations, and is usually associated with a strong proof system for apodictic demonstration of geometric facts. The abstraction in [32] through which a geometry of IR is suggested, is however, not an abstraction from matter or the material world, at least not in any literal sense. Instead, it is an abstraction, from an existing abstraction of the material world. This is similar but also different to the world of quantum theory that inspired the particular use of geometry in [32], where the said geometry corresponds to Hilbert spaces and operator functionals. In quantum theory geometric representations represent detectable (i.e. observable) aspects of a non-corporeal micro world, while this is not equivalent to how geometry is used in to represent the classical Newtonian physical world, there is much congruence relative to the difference between that same classical world of natural science and the corporeal world of users and systems.

We note that, even though one uses the geometric and mathematical setup of quantum theory, any geometry of IR *given that is is about corporeal phenomena of a human and artificial sort*, must be a geometry in quite a different sense than for both newtonian and quantum mechanics. The abstraction in the latter cases is always from matter (however conceived) and from an already existing abstraction in the former. As such, we claim that the notion of geometry in [32] is best understood in the way Ashby [6] frames Cybernetics (and its corresponding modelling apparatus), as dealing with *"all forms of behaviour in so far as they are regular, or determinate, or reproducible. The materiality is irrelevant, and so is the holding or not of the ordinary laws of physics.City"*, that is, Cybernetics is to *"the real machine–electronic, mechanical, neural, or economic–much as geometry stands to a real object in our terrestrial space."* Thus, given this definition, the geometry of IR–the collection of users, systems, institutions, libraries etc.–is firstly akin to a cybernetics, not a mathematical physics; it is only on further abstraction that it can become so. In being akin to a cybernetics (or systems theory more generally) more so than a quantum mechanics/theory, IR is more amenable to be understood as mechanism *not* mechanics: this is an important distinction.

The work in [3], in developing on from [32] inadvertently modelled IR processes as cybernetic processes, as it found such a model as a necessary intermediate step before abstraction using a quantum theory inspired apparatus. This paper analyses explicitly the sense in which the typical cybernetics models are a model of IR processes, and more suitable therefore to be called a geometry and how the modelling of IR nevertheless has to go beyond cybernetics. Section 2 relates some cybernetic phenomena to retrieval phenomena. Section 3 discusses the limiting behaviourist nature of cybernetics, while section 4 argues that therefore IR has to be recontextualised beyond cybernetics and behaviorism. Section 5 discusses one particular methodological implications of such a recontextualisation, which has to do with how the researcher investigates phenomena. Finally, section 5 concludes the paper.

2. RETRIEVAL AS A CYBERNETIC SYSTEM

Several concepts in [3] that came about due to trying to frame IR (and by extension Information Retrieval and Science, or IR&S in general see [5]) in a way that made it *available to* formal analysis *as a whole*. The framing of it was biased by a state-based thinking, that the user and system are part of a dual-system each part having subdivisions within that corresponded to different aspects, similar to the OSI-ISO diagram of nodes on a network. It was based on the understanding that the interaction phenomena between the parts and the observable phenomena on the whole system (system seen as a whole) would be best described using a language that was set-theoretic (and hence open to logic), geometric (and hence open to a rich vocabulary of mathematical structures, symmetries and such)

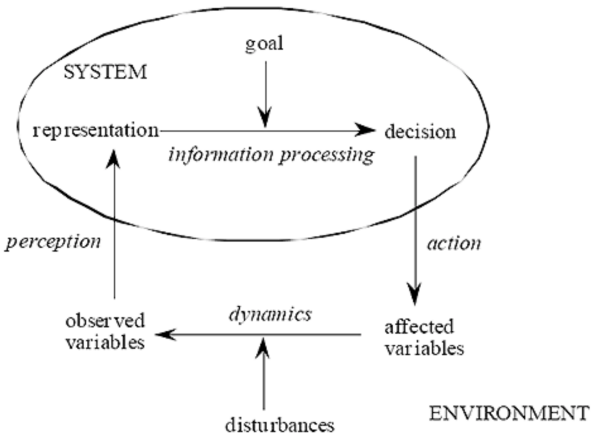

Fig. 1. Typical Cybernetic System

and statistical/probabilistic (and hence open to 'real-life' in that the statistical psychology inherited by IR in how it models a user can hopefully be embedded here).

This understanding lead to a restricted understanding of some more cognitive and social concepts such as the hierarchy of gaps/needs (semantic gap, knowledge gap, social gap and experiential gap as the four generalized levels of information need, [3, Ch. 3.4]), the system understanding problem or SUP (how the user understands and is affected by the system), and user understanding problem or UUP (how the system understands the user). Prior work looked at them in a 'goal-like' way, such that the UUP/SUP and gaps denote states of the dual-system, and that that their 'resolution' (which become partial goals of a search) could be defined by a particular set of interactions, and the extent of their resolution can therefore (at any time) be represented and possibly measured. This naturally implied that computational simulation was the best way to investigate the scenario such models represented. This means that even the subjective world of the user, something accessible to us as researchers as we have access to a similar world due to having access to our cognition, would be investigated by first framing usage scenarios and doing extensive counterfactual analyses based itself on a combinatorial analysis of the different possible interactions given a specific instance of each component such as an interface state, a state of user behaviour, corpus state, etc. As it stands this need to model a two-agent goal-oriented communicative system with multiple parts, processes, and with the observer's (i.e. researcher's) knowledge of it changing over time (hence from a relative black-box to more detail), is precisely the kinds of model dealt with in Cybernetics [6, 36, 26], in particular second-order cybernetics [34, 35, 15, 17]. And while the cybernetics literature was not known to the author while writing the work in [3], the said work essentially presents information retrieval as a cybernetic system, the typical model for it is depicted in Figure. 1.

The advantage of what was essentially a cybernetic model in [3] is the arsenal of mathematical modelling techniques that can be applied to capture the variation of scenarios. The following sections give examples of IR phenomena considered as cybernetic phenomena, and the mathematical modelling techniques that could be advantageous in each stage.

2.1 Feedback and Control

The processes of observation (see Figure. 1) between researcher and user or system agent could be considered as feedback depending on the influence the observation has on the agents. There is clearly feedback between user and system (the action in Figure. 1, and one aspect of this is the relevance feedback addressed by IR discourse [9]. However, the natural interaction that one may choose to model between subcomponents of agents is also a type of feedback. As for control, this requires one agent (and by extension, some component within agents) to take precedence over some other, this is the asymmetry constraint relevant in the IR case. The user is the controller, they lead the system, the system is servile to them and not otherwise. Thus, as the user is the goal-setter, the entire system of their needs (such as information needs and others, see [37, 38, 39])

2.2 Stability

This notion in cybernetic systems is often further represented using dynamical systems (whether discrete and using differential equations, attractors and so on, or discrete and using difference equations, see [19, 12]) which was captured by the corresponding notions. Firstly, *Specific Convergence*: the point at which user knows enough about the user interface in order to user it "effectively" (related to the SUP see above). Thus, there is convergence between what they seek to know and what they know, it is the acquiring of knowledge. Secondly, *General Convergence*: meeting of complex search goals such as a set of particular "interaction experiences" (with respect to meeting the experiential gap). This is a more general convergence, of intended goals (whether that is knowing as in specific convergence), and meeting them.

2.3 Identity

The using of group-theoretic methods to represent 'identity', referring here to a set of operations which take a system from one state through a series of changes until returning to the same state. For example, the state of not knowing to a state of knowing through intermediate states of partially knowing something. The use of an energy metaphor to speak about the likelihood of potential changes to become actualized.

2.4 Coupling

This refers to the kinds of relationship between parts of a system, i.e. the mereology. For example, the user has different abilities through which they observe an act such as memory, behaviour/action, semantic/language understanding, what kinds of parts are these are how do they interact? Moreover, how can two separate entities be said to 'relate' to each other, can they be 'coupled' just as two components of the same system are except with respect to an environment? According to [3] this is precisely the relation between the user and system agents in a search process which takes place in a situation or environment. Coupling could be represented by functions, set-subset relations (in general), or similarly, tensor product (more generally) relations as employed in [3] due to being influenced by the analogical situation in quantum theory (see also, [4]).

2.5 The upshot

It is difficult not to be swayed by the corresponding rich mathematical theories one could employ for IR given this correspondence with cybernetics, and indeed with quantum-level systems as ex-

plained in [3]–albeit taken in a reduced sense [1]. However, since we take the goal of science as understanding things as they really are–to the extent possible–over how aesthetically pleasing representations may be, there is a hard realization here that leads us elsewhere, and that is the question of meaning. That is, if we seek to explain *why* users do what they do in using our systems and not just how they do it, then we must consider this idea of meaning beyond that of behaviour, and as an explanatory principle.

Thus, whereas in behavioural cybernetics systems and indeed in the physical world of quantum theory, laws, maxims, structures seem to fair well in depicting their object–that is, the physical world tends to "mean" what the equations "say" for the purposes of experiment–in the 'mental world' (or world of embodied mind) and world of artefacts (human created objects) things mean more than can be captured by mathematical abstractions. For example, while the mathematical cognitive science of Gardenförs [16], does help model cognition, it captures but some aspects of rational decision making, which is itself a limited aspect of cognition. Thus, while mathematical metaphors were necessary and very useful, they were definitely not sufficient–that to say human interactions (with technology) and thought patterns mean what my 'state-based equations' say would be a proposition a few orders more removed from its subject than the prior case. The next section further explains why behaviorism is problematic for our context.

3. BEHAVIORISM AND ITS LIMITS

The problem with the cybernetics approach is the thoroughly behaviourist way of looking at the user and the search scenario, and with the deeper implications of the second-order approach–which, since it brings in the observer/researcher, entails bringing in research methodology into the modelling of that which is the subject of that same methodology. In particular, for the second issue, the observation here is a phenomenon of a different category than the observation of a user or a system, research methodology is the domain of philosophy not mathematical modelling, especially when brings to bear the wide discourse on observation/research biases discussed in science studies, Foucauldian analyses, and the sociology and philosophy of science.

With respect to the first issue, looking at people/social-scenarios (like the IR experiment) in a machine-like way, misses out much, and is reductive. The human being is a being, it has being, this is something more than their movements, even if it the 'mental movements' (or state changes represented by mathematical variables). There is indeed a wealth of conceptual vocabulary that can be used to explain such phenomena, except that they are beyond the typical cybernetics discourses. And before they could be properly used we would need to delve ourselves into the discursive traditions that originated them and familiarise ourselves with their problematics: such as to the particular ontological relationship between man and technology–this goes beyond just 'user as controller of system', and differs according to context. The place of intentionality and consciousness in all this, how do we model it–if we are supposed to at all? Behaviour is intricately linked to these aspects, but could never replace them. There is the wider concern about the environment here, that is, relations between technology, politics, the academia and media, that technology is not 'neutral'–so for example, while the user is said to be in control, it is equally true that in some sense the system is in control, and more so, that it creates an illusion of the user being in control. As to the goal-directedness here of the controller, there is therefore a difference between their information *needs* and information *wants*, and moreover, both can be manufactured or real, and if real then individually or socially constructed.

Users "dwell" in their experiences, in their technology-mediated experiences in a way analogical to their dwelling in a physical place. This is not at all simply the physical being in a place or environment, or a simple association to a physical place as a cybernetics model will depict, and this is illustrated by the cybernetics inspired work of Alexander in [1, 2]–which in some sense transcends cybernetics–as well as the phenomenologically oriented work of [24]. In dwelling in a place that they seek aesthetic experiences (sometimes characterised as 'unfamiliar' experiences, experiences of novelty as informative) with the objects in the world that include the technology we make, i.e. "on youtube", which are enmeshed in cultural frameworks in which they participate. That "context", meaning the majority of the aspects of human conscious experience, is deep, relatively unexplored (in IR) and explorable, but we need a 'trans-mathematical' way to frame it and the resultant rhetoric can be rigorous whether mathematical models are used or not, yet it would be useful, "scientific", and necessary to make IR (and IR&S) into the transdisciplinary science we think it needs to become. IR is thus suited since it finds itself designing tools, initially in the restricted environment of the library but now without specific context (especially with the ubiquity and integration of such tools into diverse cultures and therefore suddenly in the middle of field with the ball in its possession in that it is a technology that affects/enables/mediates human culture, learning, psychology, politics.

It is therefore in the middle in the sense that it needs to consider it's own context, the academic disciplines studying these areas, and see itself as part of them but offering a domain of investigation. And it requires to consciously and actively appropriate from these disciplines in a purposeful way, but first it needs to understand or at least re-evaluate what it is and what it's purpose therefore is; in order to do this it needs to be contextualised.

4. IR IN CONTEXT

In order to understand IR in a broader context we need to extend the boundaries of our usual analyses. Instead of "starting with IR" we start with the following alternates of its sub-aspects:

(1) Technology' prior to retrieval systems
(2) Culture and conscious experience prior to action/response/interaction (from an 'user')
(3) Concepts of writing, disciplinary systems, reading, media, aesthetics (and culture again) and production prior to document
(4) Human needs, politics, economics and ecology prior to query
(5) Value, relief, prior to relevance
(6) The 'form' in information prior to information as ambiguous reference to multiple non-compatible meanings.

There have indeed been multitudes of studies that address notions of information process, behaviour, retrieval, access, management and science in the context of one or many of these areas. The problem is that the corresponding analyses therein do not form part of some core analytic or standard in IR&S, and so those researches fall away over time since the central (computational or statistical) notions of IR&S do not accommodate this broader context as being of importance. Thus the central notions need to be

[1] That is, IR system-use is not like the interaction between micro-level systems depicted in quantum theory, they differ ontologically. People and machines are *not only* physical matter, this lower level does not sufficiently explain the higher.

changed and it is not a matter of doing several studies that would then become supplementary 'points to note' but instead it is a matter of addressing foundations. The following expresses some of the most important foundational issues

4.1 Being Informed

A particularly, important foundational aspect that requires perusal is the root overall process in IR&S that of being informed. This could mean (1) to know something that one did not know before which from an external perspective refers to a change in the representation of knowledge (in the observer, of the user agent) ; or (2) to know something that now clarifies what one needs to select amongst numerous possibilities. This means to home to get closer to a solution (a single or small set of goal possibilities). It could mean simply to know something of a specific type of value such as pragmatic value. Information as the means of change is common to all these meanings, the difference between them being the nature of that change. In the second case change means to reduce possibilities, the change is supposedly useful or the fulfillment of a value, and in this sense it is a "difference that makes a difference" [8]. A foundational question here is what the difference is between those two differences. This is a philosophical question linking back to philosophical psychology and metaphysics, if it were to be a question not just of representation but of the reality it represents.

This is a question about the difference between what the observer of a user perceives to be a difference, and their judgment of that difference as being of value. The former is an apprehension and the latter a judgment as studied in classical logic [2]. Thus, while cybernetics can help us model user-system dynamics, and provide a preliminary means for us to clarify how we as observers are thinking about any such scenario, it presupposes a more foundational understanding of how we come to know things, the logic of perception and judgment, etc. And through such study it becomes clear that any definition of information must be hierarchical, that there is a general notion of information which is related to more specific notions of it, and that the specific notions are related to the general one.

4.2 Forming a new context for IR: the issue of purpose

If a set of definitions could be devised which where general enough to accommodate IR-relevant related concepts from the disciplines of the broader context then one would be appropriating from these disciplines and putting IR in context. It would, in the Lakatosian sense, be providing a set of *positive heuristics* that would open up new avenues of research, but it would be *purposeful*. However, what is that purpose as without knowing that IR can be made to refer to anything–what is specific to IR? This is indeed a difficult question and to attempt it we first assume that the of purpose is creating devices which can improve effectiveness/efficiency in the way they are presently understood in IR (and even in the creative concept stretching), although an useful (or even necessary) purpose, is not a sufficient one. We justify this by noting the increasingly rich ways people use IR software, especially in the the application of ubiquitous computing, such that the software/device is embedded in such complex cultural processes that the "problem of search" (and the users' goals) here concerns more the understanding of those processes and less so their technical/instrumental representations (through user interactions with relevant/non-relevant items), and mathematical models (i.e. statistical ones from machine learning for example) which are not sufficient for representing those processes in a form that is conducive to scientific analysis–by which we mean analysis through human-scientific activity as opposed to only (meaning deprived) statistical analyses.

This is since scientific activity requires building of theorems and the objects of study are users, behaviours, cultures and such, who cannot be understood through machine intelligence without first being understood within the confines of "humanistic science" in the same way as the physical world is not understood through experimentation and their statistical analyses except with reference to a theory of the physical world. The notions of user, query, document and information in IR are not sufficient in capturing the richness of phenomena, and so alternative theories are required.

What then is, or ought to be the sufficient purpose(s) of IR? Information science (and hence IR) finds its purpose defined by founders such as Paul Otlet [25], Suzanne Briet [10] and others [3], as that of *supporting and enabling* a particular type of (democratic) society, one built on a particular set of values, a mythos, an urban and architectural setup and an socio-econo-political setup. Its purpose is to support a society in which people are given the ability to know what they ought to know (to be citizens therein, to live in peace, to achieve virtue or manifest relevant values etc) through means supported by artificial devices or systems of operation both of which are understood as aspects of technology. However, for this purpose to be well-defined at a point in time the concept of society therein, the mythos and values, the urban and cultural forms, the econo-political setup, and in particular the notion of technology therein, these must remain under continual critical discussion due to the meanings of concepts changing over time.

Moreover, the results of that discussion must be actively appropriated into forming the purposes for IR&S which in turn would direct the project of creation of the corresponding technologies. We found that such discussions are pervasive in the humanities and that therefore it would be necessary not only to rigorously appropriate from them, but also to orient our discipline in a way such that similar discussions are *natively* accommodated and there is an organic system of analysis between that type of discussion and the creation of systems and techniques. We also found that the version of this discussion that underlay current IR is dated and unless it is allowed to be explicitly addressed in an open setting (as opposed to for some particular IR application in a particular research project) the growth of IR suffers problems since its hard-core (its purposes) remains out of date and it is difficult to relate to the modern setup (in the areas mentioned above), and thus it becomes difficult to develop the subject as the usual directions of development [4] become clogged leading to a plateauing effect. This means that although the discipline is generating new 'facts', that there seems to be a collective understanding that the new facts do not *sufficiently add* to the discipline [5, Chapter 3], and in that sense the mainstream research programme in the discipline (or just the discipline depending on how one views it) has become, in the Lakatosian sense, degenerative [5, Chapter 3].

[2]The judgment here is an ethical one, but this need not be a simple judgment. There could be parts. For example, one would presumably assess first of all, whether the difference apprehended is relevant with respect to a value judgment

[3]See also Kochen[21], Swanson [30, 31]

[4]That is, aimed to increase effectiveness, or a similar 'instrumental goal', or scattered user-group specific (statistically defined) goals–a statistically significant number of users have to not be indifferent to some system feature)

In contextualising IR, instead of concentrating on the purpose of IR (with the old foundational definitions) we thought to see IR as a technology where technology is meant not only in the sense of the IS founders (Otlet et al. above) but also in the sense meant by some of the works in the areas of philosophy of technology (Heidegger, Ellul, Mumford, Feenberg). It turns out that notions of information can be formulated at the level of IR-as-technology which offer interesting perspectives on the (cultural) problem of search and associated notions (relevance, query, etc). Thus the entry point analyses to construction of this "science" is a discussion of purposes of technology and what is presupposed (a city or polity or otherwise) therein. In particular, it need to include be based on a notion of information, as that the factor by means of which such an aspirational future IR discourse could be related to a general study of socio-technics.

4.3 NOTION OF INFORMATION

The way the term information is used, as a trope in political/technological rhetoric, the place it therefore plays in such rhetoric, and the role that rhetoric plays in the grander rhetorics, is important for understanding the intellectual, institutional, economical and general-cultural dynamics of our time and thereby, as we hope to show, the precise meaning of the modern period as being an information *age*. It is crucial to note that the information trope [11] takes a place within rhetoric which was partially occupied by the word 'form', in the Platonic sense and also in the common sense, and that these two terms (therefore) have a semantic relationship which we propose stands, on analysis, to explicate cultural-frameworks; by culture we mean the collective habits of a group of individuals. The notion of habit here is quite generic, from psychological tendencies and epistemologies, institutions, polities and organizational practices, ecologies and methods of exchange (economies), and material aspects best described as that which is the subject of study in archeology, geography and aspects of anthropology. The forms of life (*Ger.* Lebensform) of groups which shape and are shaped by the life-worlds (*Ger.* Lebenswelt) and habitus[5] (*Grk.* hexis) of individuals, and ultimately (ontologically) the being-in-the-world or way of being (of being *there*) of man as *Dasein*, constitute this cultural-framework. Within such a framework, with respect to such a context does language: spoken, written, gestured, acted or built, become understood and mean something, through a hermeneutic/interpretive discourse and ultimately through dialectics[6], the movement or life aspect of the forms.

If the notion of information is thus, involving rich layers of reality, from the social, personal (psychological and behavioural), ontological and others, how could one begin to even talk about 'information retrieval' in the way meant in the eponymous discourse? This is especially the case given that the various notions used in IR discourse, from document, query, relevance, user and system, ultimately depend on the notion of information. To this end we take a position contrary to [14] where the relation between information and information retrieval or science discourses is seen as not being necessary; see the discussion on p229, and chapters 5 and 6 in [5]. We would only agree with this if a very specific notion of information is meant. However, to the extent this information refers to changes or their precursors, or is used to explain communication between system and user, or between arbitrary agents–while we might opt to rename all those instances of 'information' with different names–the 'place' of seems to be a mainstay.

[5] Savolainen in [27] adapts Bourdieu's concept of habitus for this purpose

[6] This refers to a ontological complement of a discourse. The discourses are related, possibly hierarchically, and necessarily hierarchically in mutual-relation with the ontological dialectic

5. THE ISSUE OF METHODOLOGY

Given the aboveWhat an IR would need to study then is man, technology, and their interactions and corresponding (informational) experiences. By interaction is meant not only those that can be objectively observed, but also those which are subjective (or inter-subjective), or those which are hypothetical; and by (informational) experiences we mean similarly, the objective, inter-subjective, subjective and hypothetical experiences, i.e. as experienced by individuals or groups, or "by cultures". What is being called for then is a research programme in the Lakatosian sense, a programme based on a "hard-core" of justified beliefs, heuristics that direct the line of enquiry and a set of auxiliary hypotheses that "protect" this hard-core [23, 22]. Some of the hard-core and auxiliary hypotheses exist, at least individually, in other programmes, as do the heuristics. It is their particular synthesis and the therefore the outlook of the programme that is unfamiliar. This is not at all positivist programme however, even though such elements are inevitable when modelling of retrieval systems is involved. It intends to posit facts, counterfactuals and their analyses, a and aid in the crafting of artefacts (i.e. technologies) that affect the objects of study, but it's object of study includes also the scientist and their experience of phenomena as being part of the object of study.

This resembles what some have called Goethean science [28] where the scientist is not an external observer but rather he/she is engaged with the observed in a reciprocal way so as to be able to interact with the observed and gain "experiential knowledge" of phenomena, the main instrument of the scientist is himself/herself. This should not be confused however with the similar dictum in ethnomethodology, let alone the second-order aspect of a second-order cybernetics, as it is positing an ethic, episteme, method, and ontology, and not only some of these as in their cases. The subject of such a science is not the natural world but the abstract world of man-made, or man-labelled objects and the way in which one engages with them in conscious experience. And especially with reference to information science, the scientists are no less 'users' than 'other users' are users of the systems they make.

As [28, 37] explains, in the methodology of Goethe the phenomena are not simply replaced by mechanisms and causes such that one then continues with abstract hypotheses *"by constructing an artificial experience in which individual phenomena are torn out of context"*. Instead, one *"stays with the phenomena; thinks within them; accedes with one's intentionality to their patterns"*. The effect of this leads to an intuition of the form or structure of what is observed, this however is not the simple geometric or physical form–but something more. This involves what resembles a feedback process, where the observer's cognition experiences a graded series–a hermeneutic spiral–of movements between the phenomenon and its background environment. This form or structure that is acquired is the gradual precipitation [28, 37] of the *"dynamic of the interaction between the observer and and observed"*. Notice here that, geometrically speaking, in the sense meant by Ashby in [6], this is a cybernetics system, yet the map that this geometry is far-off the terrain. What is being spoken of is a phenomenological discovery process, going to the phenomenon itself (and overcoming the Cartesian and then Kantian bifurcations, of mind-matter and phenomena-noumena), that Husserl speaks about [20], as does Peirce [7, 29], and indeed as was somewhat familiar in pre-Cartesian classical philosophy [13, 18]. In addition to this type of investigative attitude, the methodology of an adequate science

of IR would require the usual critical (argumentative) apparatus (or techniques) by which to deconstruct scenarios in certain terms in order to make judgment.

What is *not* being called for is the usual non-critical 'borrowing' of heuristics from other fields and modelling them in a behaviourist paradigm, Instead we need to *critically appropriate*, and in order to do this there needs to be a rigorous understanding of where "we" stand, what our foundations are or ought to be. This starts through understanding the meanings of the key terms, especially information, but understanding them in historical as well as philosophical and 'technical' contexts. And then there has to be a building up, i.e. a redefinition of the terms (and/or addition of new terms, phenomena, 'frames').

In addition what is also being called for is a particular, Goethean and then phenomenological, attitude, through which one *apprehends* the objects of analysis. Through which the phenomena (i.e. the user) are not viewed (primarily) in an instrumental (i.e. technology-tied) way. Thus we don't only think that the human is a 'user' of a technological device but a participant in a cultural system. That the 'user sits with a machine, interact and gets feedback and interacts again until reaching a goal' view offers insufficient explanation, that it is instrumental/mechanical and "interface-like"/algorithmic. At one level "we" are (and ought to be perhaps?) 'tool makers', crafters involved in techne, making it appropriate to think of users as 'using tools according to steps'. However, we argue that we are (or ought to also be) analysts and scientists, we want to understand (at the least) how the experience of tool use appears to the user, and this requires mentioning that which is other than interaction behaviour [3, 152]. It requires understanding of how the user's experience with a tool that we make fits in with their other experiences (are they related in some way perhaps?). It requires understanding of our own context and values, and it requires us to seriously re-evaluate them (see prior section).

6. CONCLUSIONS

The many benefits of the quantum theoretic paradigm of [33] can be better realised by first understanding IR processes as essentially cybernetic processes, at least from a mechanistic/behavioral point of view. That the cybernetic elements (stabilities, identities, feedback loops and goals, etc.) of retrieval should form the primary phenomena that we seek to model. However, while such modelling can only be a small, while necessary part of any rigorous science of Information Retrieval. As argued above, the mechanistic/behaviorist point of view of cybernetics (even second order cybernetics) needs to be overcome as further detailed in [5], and this means to recontextualise IR and related discourses (such as Information Science), in a significantly broader *but rigorously connected* disciplinary space than is currently afforded them.

7. REFERENCES

[1] Christopher Alexander. *A Pattern Language: Towns, Buildings, Construction*. Oxford University Press, Oxford, 1977.

[2] Christopher Alexander. *The Timeless Way of Building*, volume 1. New York: Oxford University Press, 1979.

[3] Sachi Arafat. *Foundations research in information retrieval inspired by quantum theory*. PhD thesis, University of Glasgow, 2008.

[4] Sachi Arafat. Senses in which quantum theory is an analogy for information retrieval and science. In Dawei Song, Massimo Melucci, Ingo Frommholz, Peng Zhang, Lei Wang, and Sachi Arafat, editors, *Quantum Interaction*, pages 161–171, Berlin, Heidelberg, 2011. Springer Berlin Heidelberg.

[5] Sachi Arafat and Elham Ashoori. *Search Foundations: Towards a Science of Technology-mediated Experience*. MIT Press, 2019.

[6] W Ross Ashby. *An introduction to cybernetics*. Chapman & Hall Ltd, 1961.

[7] Richard Kenneth Atkins. *Charles S. Peirce's Phenomenology: Analysis and Consciousness*. Oxford University Press, 2018.

[8] G. Bateson et al. *Steps to an ecology of mind: Collected essays in anthropology, psychiatry, evolution, and epistemology*. Paladin St. Albans, 1973.

[9] Keping Bi, Qingyao Ai, and W Bruce Croft. Revisiting iterative relevance feedback for document and passage retrieval. *arXiv preprint arXiv:1812.05731*, 2018.

[10] Suzanne Briet, Ronald E. Day, Laurent Martinet, and Hermina G. B. Anghelescu. *What is documentation? English translation of the classic French text*. Scarecrow Press, Metuchen, New Jersey, 2006.

[11] Ronald E. Day. *The modern invention of information: Discourse, history, and power*. Southern Illinois University Press, 2008.

[12] D Dutta Majumder and Kausik Kumar Majumdar. Complexity analysis, uncertainty management and fuzzy dynamical systems: A cybernetic approach. *Kybernetes*, 33(7):1143–1184, 2004.

[13] Nader El-Bizri. *The phenomenological quest between Avicenna and Heidegger*. Global Academic Publishing, 2000.

[14] Jonathan Furner. Information science is neither. *Library Trends*, 63(3):362–377, 2015.

[15] Peter Gärdenfors. *Knowledge in flux: Modeling the dynamics of epistemic states.* The MIT Press, 1988.

[16] Peter Gärdenfors. *The Geometry of Meaning: Semantics Based on Conceptual Spaces*. MIT Press, 2014.

[17] Ranulph Glanville. Second order cybernetics. *Systems Science and Cybernetics*, 3:59–85, 2002.

[18] Martin Heidegger. *Plato's Sophist*. Indiana University Press, 2003.

[19] Richard A Holmgren. *A first course in discrete dynamical systems*. Springer Science & Business Media, 2012.

[20] E. Husserl. Philosophy as rigorous science. In *Perception; selected readings in science and phenomenology*, 1969.

[21] M. Kochen. *The growth of knowledge: readings on organization and retrieval of information*. John Wiley & Sons, New York, 1967.

[22] I. Lakatos, J. Worrall, and G. Currie. *The methodology of scientific research programmes*. Cambridge University Press, Cambridge, 1980.

[23] Imre Lakatos. *History of Science and its Rational Reconstructions*, pages 91–136. Springer Netherlands, Dordrecht, 1971.

[24] Christian Norberg-Schulz. *Intentions in architecture*. MIT press, Cambridge, MA, 1968.

[25] Paul Otlet. *International organisation and dissemination of knowledge: selected essays of Paul Otlet*. Elsevier for the International Federation of Documentation, Amsterdam, 1990.

[26] Andrew Pickering. Cybernetics and the mangle: Ashby, beer and pask. *Social studies of science*, 32(3):413–437, 2002.

[27] R. Savolainen. Everyday life information seeking: approaching information seeking in the context of. *Library & Information Science Research*, 17(3):259–294, 1995.

[28] D. Seamon and A. Zajonc. *Goethe's way of science: A phenomenology of nature*. State Univ of New York Pr, 1998.

[29] Herbert Spiegelberg. Husserl's and peirce's phenomenologies: Coincidence or interaction. *Philosophy and Phenomenological Research*, 17(2):164–185, 1956.

[30] D.R. Swanson. Undiscovered public knowledge. *The Library Quarterly*, 56(2):103–118, 1986.

[31] D.R. Swanson. Historical note: Information retrieval and the future of an illusion. *Journal of the American Society for Information Science*, 39(2):92–98, 1988.

[32] C. J. van Rijsbergen. Quantum logic and information retrieval. In *2nd Workshop on Information Retrieval, Uncertainty and Logic*, IR Group, University of Glasgow, Scotland, 1996.

[33] C. J. van Rijsbergen. *The Geometry Of Information Retrieval*. Cambridge University Press, 2004.

[34] Heinz Von Foerster. Cybernetics of cybernetics. In *Understanding understanding*, pages 283–286. Springer, 2003.

[35] Heinz Von Foerster. *Understanding understanding: Essays on cybernetics and cognition*. Springer Science & Business Media, 2007.

[36] Norbert Wiener. *The human use of human beings: Cybernetics and society*. Number 320. Da Capo Press, 1988.

[37] Tom D. Wilson. Information needs and uses: fifty years of progress. In Brian C. Vickery, editor, *Fifty years of information progress: a Journal of Documentation review*, pages 15–51. Aslib, London, 1994.

[38] Tom D. Wilson. Models in information behaviour research. *Journal of documentation*, 55(3):249–270, 1999.

[39] Tom D. Wilson. On user studies and information needs. *Journal of documentation*, 62(6):658–670, 2006.