Re-thinking the Ontology of Information

Completed Research Paper

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Abstract

Information, though a core concept in Information System research, has been taken for granted by scholars for many years. Recent studies have attempted to shed light on this concept by classifying information theories and proposing new conceptualizations. However, there remains much discord on the nature of the information phenomenon, and whether a unified definition is achievable. By drawing on the tenets of Critical Realism and examining the philosophical and ontological assumptions of existing theories of information, we propose a stratified framework to explain the complexity of the information phenomenon. This framework provides opportunity for interdisciplinary work and can aid researchers to make better informed choices in terms of research questions and approaches when studying information or related phenomena.

Keywords: Information, ontology, critical realism, under-labourinng

Introduction

Information is a central concept in Information System (IS) research. However, despite its omnipresence, it has remained a predicament for IS research, seldom explicitly specified in extant IS literature (Lee, 2010). Several scholars have espoused the need for deeper understanding of the theoretical foundations of information to underpin IS research (e.g. Boell 2017; Lee 2010; Mingers and Standing 2017). Related debate has spanned disciplines beyond IS, including: information science, computer science, communication and even philosophy, biology and physics. Discussion in information studies (studies from different disciplines focused on information) emphasizes philosophical underpinnings of the notion of information (Mai 2013; McKinney and Yoos 2010). Authors within IS have defined information variously as 'data', 'processed data', 'meaning' and 'knowledge'. Definitions offered tend to be ambiguous and often irreconcilable.

IS scholars, including Stamper (1991), Mingers (1995; 1996), McKinney and Yoos (2010) and Boell and Cecez-Kecmanovic (2015) and Boell (2017), have sought to consolidate information definitions at a meta-level, seeking to bring clarity to the concept of information and its use in IS studies. Mingers and Standing (2017) argue that IS must establish the theoretical foundations of a broad notion of information which spans IS and its cognate disciplines. Others (e.g. Boell and Cecez-Kecmanovic 2015; Boell 2017) argue that IS should accept a range of conceptions of information that researchers can draw from dependent on the research problem of interest.

While we are of the view that a unified definition of information is not achievable, by drawing on tenets of Critical Realism (CR) and examining the philosophical and ontological assumptions of existing theories of information, we propose a stratified framework of information to explain the complexity of the information phenomenon. This framework provides the opportunity for interdisciplinary work, and can assist with methodological choices when studying information or related phenomena such as information quality.

Background

Despite being the central concept of IS studies, the notion of information has been taken for granted in IS research, and the use of this term has been mostly limited to the processes of generation, transmission and storage of data (McKinney and Yoos 2010). Stamper (1991) was one of the first scholars to propose an alternative, semiotic understanding of the term. Stamper (1991) extended the semiotic theories of Peirce (1931-1958) and Morris (1938) to IS research, seeking to achieve a comprehensive view of information (Boell and Cecez-Kecmanovic 2011). Stamper (1991) introduced three other semiotic levels. In addition to those of Morris's semiotic framework (Morris' levels being syntactic, semantic, and pragmatic), Stamper introduced social (shared social context), empiric (statistical properties of the sign representation) and physical (material properties of the media). Stamper's argument is mainly focused on the existence of information at all semiotic levels, assuming a mutual interaction between those levels. Stamper's adaption of Peircian semiotics has been criticised for being inconsistent in its philosophical assumptions and with Peirce's pragmatic position (Beynon-Davies 2009).

Mingers (1995) first proposed his theory of information based on analysis of communication, cognitive and semiotic theories. He defined information as objective, and as the propositional content of the sign system. He differentiated between meaning (being subjective), information, and data. A main critique of Mingers (1995) original theory, is that it limits the information conception to the objective view and overlooks how different conceptions of information can be applied to deal with different research problems. His more recent views (Mingers and Standing 2017) again emphasize the objective and veridical nature of information, extending the original theory and discussing implications of the extensions for IS research and practice.

In 2010 McKinney and Yoos invited the IS community to get more deeply engaged with the definition and conceptualization of information. Their paper opened up new research questions and challenges regarding the concept. McKinney and Yoos suggest that IS is better served by a taxonomy of information views rather than a single definition of the concept.

Sebastian Boell is another IS scholar who has engaged with information studies (Boell and Cecez-Kecmanovic 2011; Boell and Cecez-Kecmanovic 2015; Boell and Cecez-Kecmanovic 2010). In his latest paper, Boell (2017) provides a rich analysis of existing information views and analyses their fundamental assumptions regarding information. This analysis yields a comprehensive taxonomy of different information views. Boell then introduces a consequential framework by comparing information theories regarding their focus on important IS concepts such as data, knowledge, sign etc., and advocates against a single interdisciplinary definition of information.

Two main positions can be distinguished among scholars on information theorization; (i) the belief that there is no single framework for information definition and that different conceptions of information should be applied in relation to different research problems (Boell 2017; McKinney and Yoos 2010), and (ii) the belief that there should be some holistic, "transdisciplinary"[1] (Mingers and Standing 2017) conceptualization of information. Mingers and Standing (2017, p. 99), in support of the latter view, conclude "at least a theory should be broad enough to cover information systems and its cognate disciplines".

We would argue that the fluid nature of information (Information is defined differently for different purposes and in different disciplines) and of its relation to technology, human interpretation, and the social context, defies current approaches to theorize information. Even though, each extant definition of information tends to have unique strengths in explaining specific aspects of the information phenomenon,

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[1] Transdisciplinary work is one step after interdisciplinary and is achieved through creating an intellectual framework beyond the disciplinary perspective (Choi and Pak 2006).

individually, each is ill-equipped to account for the complexity of the phenomenon in the open and dynamic world we live in (Bhaskar 1998). Current information theories are constrained by assumptions underpinning their respective paradigms (e.g. positivism, post-positivism, interpretivism and constructivism) that shape how a phenomenon can be approached, and the aspects researchers are able to attend to (Dobson 2001; Garcia and Quek 1997). To overcome this roadblock and understand the complex nature of information, researchers need to be able to position and interrelate extant theories of information. Debate on the definition of information is fundamentally philosophical, and are based on diverse ontological and philosophical perspectives (e.g. Floridi 2002; Mingers 2013). To be able to position and compare different theories on information which are based in different or even seemingly contradictory philosophical ontologies, we need to be able to differentiate between knowledge and the objects of knowledge; or we need to differentiate between 'philosophical ontology' and 'scientific ontology'. An important distinction is made here between a philosophical and a scientific ontology. In CR accepted scientific ontologies are considered to be interpretations of reality produced by science (Bhaskar, 1998) whereas a philosophical ontology aims to generate a generalized, conceptualised schema of a phenomenon that is independent of scientific knowledge. Consequently, the objective is to first establish a philosophical ontology from which to identify useful scientific ontologies (the foundations of empirical work) that subsequently pinpoint epistemological standpoints and therefore appropriate and powerful methodologies.

Critical Realism recognizes that the capacity to produce a useful explanation of information as a complex phenomenon, is methodologically constrained by competing, ontologically incompatible approaches. The objective of CR is to critically utilize this existing research to identify a philosophical ontology that overcomes existing scientific ontological barriers.

Here it is worth noting that CR characterises phenomenon in two ways: the *transitive* and the *intransitive*. Intransitive aspects of a phenomenon consist of objects and structures (*"Objects, or more generally entities, are the basic theoretical building blocks of critical realism"* (Easton 2010, p.120) that possess causal powers; be they molecules, things, organisations, people, resources, relationships, ideas and so on. Sayer (1992, p.92) defines *"sets of internally related objects (entities) or practices"* as structures. Herein, we use the terms objects and structures interchangeably) that exist independent of any knowledge that might be held about that phenomenon. All views and theories of information exist in the transitive dimension and are considered to be potentially fallible and therefore open to revision. Bhaskar (1993, p. 21) considered the transitive aspects of a phenomenon to be the *"raw material of science..., the established facts and theories, paradigms, methods and techniques of inquiry"*. According to this fundamental ontological assumption, the multiplicity of information views evidences a multiplicity of intransitive objects and structures that form the information phenomenon conjunctively (Bhaskar 2010). This is different from prior frameworks such as (Boell 2017) who refers to this multiplicity more in terms of disjunctive plurality. Information as an emergent multi-layered social phenomenon is not reducible to any single structure such as technology, individual, or social aspects. According to CR, information will have a fixed ontological status (intransitive dimensions), but existing research and information theories are continually evolving (in the transitive state), particularly in light of emerging technologies and praxis applications. This enables us to: (i) differentiate between existing theories about the information phenomenon, and information itself; and to (ii) draw on existing knowledge to begin establishing the ontological status of information. To achieve this, we rely on Bhaskar's (1998) under-labouring approach, which, consistent with CR[2] philosophical assumptions, which lets us differentiate between a philosophical ontology and the scientific ontologies of different information views, and thus makes it possible to compare and position different views of the phenomenon in relation to each other.

Methodology

As mentioned, this study relies on philosophical principles of CR established by Bhaskar (1978; 1998). CR's strength lies in its capacity to; a) accommodate multiple scientific ontologies, and b) re-think the ontological foundations of a complex phenomenon. Bhaskar (1978; 1998) argues that the world is stratified in different

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[2] The authors realise the paper as-is requires the reader have some background knowledge of Critical Realism. Both space and time have limited our ability to make these notions more readily accessible in this paper. It is yet our ambition to make these notions more accessible, both for presentation at ICIS and for an intended follow-on journal submission.

hierarchically organized levels. This level stratification is made evident by the cumulative work of science that seeks to reveal ever increasing layers of reality. 'Level stratification' (Elder-Vass 2007, p.161) refers to *"stratification of the intransitive world into levels; the atomic, the molecular, the biological and the like"*. The objective of level stratification is to reveal and order these layers through a critical review of the knowledge base. Each level is serviced by a 'scientific ontology' well equipped to reveal and explain entities and mechanisms within one stratum (mechanisms in CR terms are inherent to the structures, enabling or limiting what can happen within a certain context (Sayer 2000).

Level stratification, (more recently referred to by Bhaskar and Danermark (2006) as a 'laminated system') describes the complexity of social phenomena and is the foundation of interdisciplinary knowledge of the phenomenon. A laminated system "refers to the body of research about the phenomenon which can be mapped to different levels of reality" (Gable 2014, p.93). A laminated system approach to information makes it possible to accommodate inter-disciplinary definitions and explanations of information within a single philosophical ontologyand to consider the value of each discipline's contribution when attempting a holistic account of information.

"CR ontological assumptions work as under-labourer" (Cruickshank 2003, p.113), meaning that they can produce *"knowledge of the necessary conditions of knowledge"* (Bhaskar 1998, p.10). Level stratification can be used as a device to reflect on existing theories (knowledge) about a phenomenon, making it possible to accommodate current information theories located within different scientific ontologies, within a single philosophical ontology. To do that, we need to differentiate between objects of knowledge (what existing information theories refer to) and their philosophical underpinnings. In this way, competing information theories can be integrated and positioned in relation to the different intransitive aspects to which they refer and thus provide the basis of an interdisciplinary explanation of the research phenomenon.

Here it is essential to differentiate between multidisciplinary and interdisciplinary. Multidisciplinary is drawing on knowledge from different disciplines but staying within disciplinary boundaries and assumptions (Choi and Pak 2006). Information has been studied in a multidisciplinary way; McKinney and Yoos' taxonomy, and Boells' (2017) consequential framework, are evidence of multidisciplinary studies of information phenomenon. Interdisciplinary research, on the other hand, requires integrating and synthesizing knowledge from different disciplines (Bhaskar 2010; Choi and Pak 2006).

Bhaskar argues that in studying a phenomenon such as information in the dynamic open world, the "additive pooling of the knowledge of different disciplines is not sufficient" (Bhaskar 2010, p.11); a synthetic integration of the knowledge is required to achieve an interdisciplinary view of the phenomenon. Accordingly, interdisciplinary requires that different approaches of different disciplines, be related to each other in terms of interactions between intransitive objects to which they attend. This is related to the concept of 'emergence' (Bhaskar 1986) in relation to level stratification. Emergence simply means that the whole (higher level entities) have properties greater than the sum of their lower levels. Any social phenomenon is a manifestation of interactions (both cooperation and counteraction) between varieties of observable or unobservable structures. Therefore, information as an emergent phenomenon cannot be studied only from an objective point of view in relation to data and communication medium. Neither can it be defined based solely on an individual's reasoning and beliefs (subjective aspects). An interdisciplinary investigation of the concept of information, rather, is able to relate and position information within different levels and subsequently investigate their emergent effects.

Accordingly in this paper, with the goal of developing interdisciplinary foundations for studying information, we first rely on different information theories and use CR ontology as under-labourer to identify a laminated system of information. We then rely on the CR tenet of domain stratification (not to be confused with level stratification (Elder-Vass 2007)) to identify how the levels in the laminated system of information interact. This provides the basis for an interdisciplinary knowledge-base of information.

Domain stratification is a CR ontological assumption (also known as the 'depth ontology') which is foundational to subsequent epistemology and methodology choices. Domain stratification (Edwards et al. 2014) refers to Bhaskar's (1998) unique identification of three distinct domains of reality: the real, the actual, and the empirical. The 'empirical' domain is where observations and experiences can be made by the observer. Events occur independently of perceived experiences in the actual domain. The 'actual' domain includes those events that occur but are not observed, as well as the empirical - observed events (Bhaskar 1978). Finally, the 'real' domain includes whatever exists, be it natural or social, its structures and

powers and its capacity to behave in certain ways. In the following we will build on these assumptions to achieve an interdisciplinary base for studying information.

Information Views

For the purpose of under-labouring we seek to address a representative range of the main theories of information from across the literature. Given the plethora of information theories (Boell 2017), we relied on two existing classifications of information theories from McKinney and Yoos (2010) and Boell (2017) who covered an extensive range of information theories and definitions[3]. We compared these two classifications of information theories to arrive at a more inclusive classification with appropriate granularity for our analysis. In comparing the two classifications, we looked at: (a) the definitions of each category, (b) the main assumptions within each category, and (c) the exemplary (illustrative) theories and definitions within each category. Though details of the comparison process are withheld due to spaces limitations, logical stages included: a)   semantic comparison of category's definition within two selected papers, b) comparing information theories within each category, c) defining new categories to be mutually inclusive of all information theories and categories in both papers. This resulted in combining or decomposing several of the original categories as summarised below. The definitions and illustrative theories derived from McKinney and Yoos and Boell are presented in Table 1 and are discussed in the following sections.

McKinney and Yoos (2010) identified four categories of information views (we use the term 'view' (consistent with McKinney and Yoos, 2010) to refer to different groups of information theories. Boell (2017), however, refers to different groups of information theories as 'stances'); token, syntax, representation and adaptation. Boell (2017) also identified four main 'stances' on information as physical, objective, subject-centered and socio-cultural, and within each stance identified a number of *sub-stances*.

Within his Physical stance, Boell (2017) identified four sub-stances; *fundamental-physical-construct, structure, structuring-process* and *transmission-of-signals*. The first two sub-stances refer to fundamental properties of the world and physical structures, which are not addressed by any of McKinney and Yoos' four categories of information views. In this paper, we refer to these two sub-stances as the Material view of information, and adopt Boell's (2017) definitions and exemplar theories.

The Token view in McKinney and Yoos (2010) can be related to Boell's (2017) *structuring-process*; both of which refer to information in relation to the processes and values (tokens), as input and output of the processes. This current paper uses the term Token view to refer to this category.

Likewise, the sub-stance *transmission-of-signals* is comparable with the syntax view in McKinney and Yoos (2010), as they both refer to signal transmission and measurable units in transmission, with both also referring to Shannon and Weaver's (1949) theory of communication as illustrative (exemplar) theory.

Within Boell's (2017) objective stance on information, the *sign-vehicle* sub-stance is not addressed by McKinney and Yoos's taxonomy. It refers to information as a physical form of representation of knowledge (Farradane 1979) and is termed 'sign-vehicle' in this paper (this definition is consistent with Peirce's definition of a sign: A sign stands for an entity which can be physical, mental, imaginary, or another sign).

Boell's (2017) *objective-facts* and *different-from-meaning* sub-stances refer to exemplary definitions from Mingers (1995) and Wikstrom and Normann (1994) and correspond with Dretske's (1981; 1983) theory of information. Since this is included within the McKinney and Yoos (2010) representation view, we refer to these two sub-stances as the representation-objective view and adopt Dretske's definition of information as representative of this view.

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[3] We also acknowledge that information theories such as Floridi's work cannot be ignored/ missed. Herein, it is necessary to differentiate between philosophy *of* science (providing scientific ontology) and the philosophy *for* science (providing philosophical ontology) (Dobson, 2001). Floridi (1999; 2002; 2003), Dretske (1981), MacKay (1955) and others are in fact philosophers on the philosophy of science. Floridi's definition of information as Standard Theory of Information (SDI) (2005; 2009) is in many respects consistent with Drteske's ideas (Mingers, 2013). However, not being explicit about his philosophical ontology, Floridi has been ontologically contradictory in his definition of information (Mingers, 2013).

Boell's (2017) subject-centered stance on information, distinguishes four sub-stances, the first two of which, *information-as-meaning* and *change-in-knowledge,* correspond with Checkland's (1998) definition of information as data + meaning, and MacKay's (1961a; 1961b) definition of information as the change in the receiver's cognitive structure. In this paper we refer to these as the representation-subjective view

The sub-stance, *internal-shaping*, within the Boell (2017) subjective stance, corresponds closely with McKinney and Yoos's adaptation view, and we adopt this term and the definitions of McKinney and Yoos and Boell (2017). The final sub-stance of Boell's (2017) subjective view is *relevant-knowledge* (also known as *pragmatic* (Kuhlen 1991)). This sub-stance relates to the concept of information beyond the individual's perception and relates information to the situational problems. The McKinney and Yoos classification does not explicitly refer to this sub-stance. Thus in the current paper we refer to this view as the pragmatic view of information and adopt Boell's (2017) definition of this sub-stance. Since McKinney and Yoos's taxonomy does not explicitly mention social views of information, in this paper we also consider the socio-cultural view of information based on the definitions provided by Boell (2017).

Table 1 summarizes the above discussion (Columns 1, 2, and 3) and lists our adopted definition of information in each view (Column 4), main assumptions of each view (Column 5), and illustrative theories in each view (Column 6).

| Table 1. Information views and the related definitions					
Boell's (2017) Stances and substances **(1)**		McKinney and Yoos (2010) Views **(2)**	Terms adopted in this paper **(3)**	Definition of information for this paper **(4)**	Main assumptions **(5)**	Illustrative theories **(6)**
Physical Stance of Information	*Fundamen-tal-physical-construct*	NA	Material	The pattern of organization of matter and energy (Parker 1973, p.10), fundemental property of the world (Boell 2017)	Information exist independent of human's perception - focuses on the structures and properties.	Thermody-namic entropy (Stonier 1990)
	Physical-Structure					
	Structuring-Process	Token	Token	Information is the processes of the physical world (Boell 2017) inputs and outputs of the processes (Mckinney and Yoos 2017)	Information exists independent of human's perception. - focuses on the processes.	(Losee 1997), (Newell and Simon 1972)
	Transmission-of-signal	Syntax	Syntax	Measurable relationship between tokens (Mckinney and Yoos 2010), measurabale transmitted signals (Boell 2017)	Information exists independent of human's perception. - focuses transmission.	Mathemati-cal theory of communica-tion (Shannon and Weaver 1949)
Objective Stance of Information	*Objective-Sign-vehicle*	NA	Sign-vehicle	Things contained in the sign vehicle (Buckland 1991)or physical representation of knowledge (Farradane 1979).	Information is objective independent of observer in contrast to knowledge in the world.	(Farradane 1979)
	Different-from-meaning	Repres-entation	Representa tion-Objective	A model of objective reality, a Sign of an	Reality exists and information is a	(Dretske 1981),

				object to an observer (Dretske 1981)	model of reality to the observer	(Mingers 1995)
	Objective-facts	(Dretske theory)				
Subject-centered Stance of Information	*Meaning* / *Change in-knowledge*	Repres-entation (MacKay theory)	Representa-tion-Subjective	Data meaningful to recipients (Boell 2017), change in receiver's cognitive structure (MacKay 1961b)	Information is internal to the observer (and their knowledge). A semantic perspective which changes the state of the message (data).	(MacKay 1961a; MacKay 1961b), (Checkland and Holwell 1998)
	Internal-shaping	Adaptation	Adaptation	Perceived difference causing system adaptation (Mckinney and Yoos 2010), Inward forming (Boland Jr 1987)	Reality doesn't exist independent of human's perception	Autopoiesis and cognition (Maturana and Varela 1980)
	Knolwedge-that is-relevant	NA	Pragmatic	Information is action or goal related knowledge (Boell 2017)	Information is not a mental concept but relevant to particular situation and problems	(Fischer 1993), (Taylor 1986)
Socio-cultural stance		NA	Socio-cultural	Information is specifed by social context, cultural factors, economic and historical developments (Boell 2017)	Information is dependent on social/cultural context rather than indivudal cognition, construct of social situation	(Cornelius 1996), (Checkland and Holwell 1998)

Table 1. Information views and the related definitions

Under-Labouring and Laminated System of Information

As discussed earlier, this paper relies on CR tenets to establish a philosophical ontology and to better understand the complexity of the information phenomenon. In the previous section, a classification of information views was introduced. CR assumes that a multiplicity of information views is suggestive of a multiplicity of levels in the transitive domain of reality (Collier 1994). Thus, different views of information, built on different ontological assumptions, reveal different intransitive stratum (within a laminated system) of 'information' as the research phenomenon. CR ontology works as under-labourer to reflect on the exemplar theories and definitions within each view of information introduced above, to assess their implicit and underlying assumptions and to further identify how they explain the intransitive aspects of the information phenomenon. This requires us to differentiate between objects of knowledge (what existing information theories refer to) and their philosophical position, then to position them under one, cohesive ontological umbrella.

Figure 1 depicts the practice of under-labouring and the resultant laminated system. Column B represents information views introduced in the previous section. Column A represents the philosophical underpinning of these views, and Column C maps the views to different levels of the intransitive domain which theories within these views explain. We refer to the result as the laminated system of Information. Following we describe the applied under-labouring process and the results.

Figure 1. Mapping information theories to the related intransitive aspects
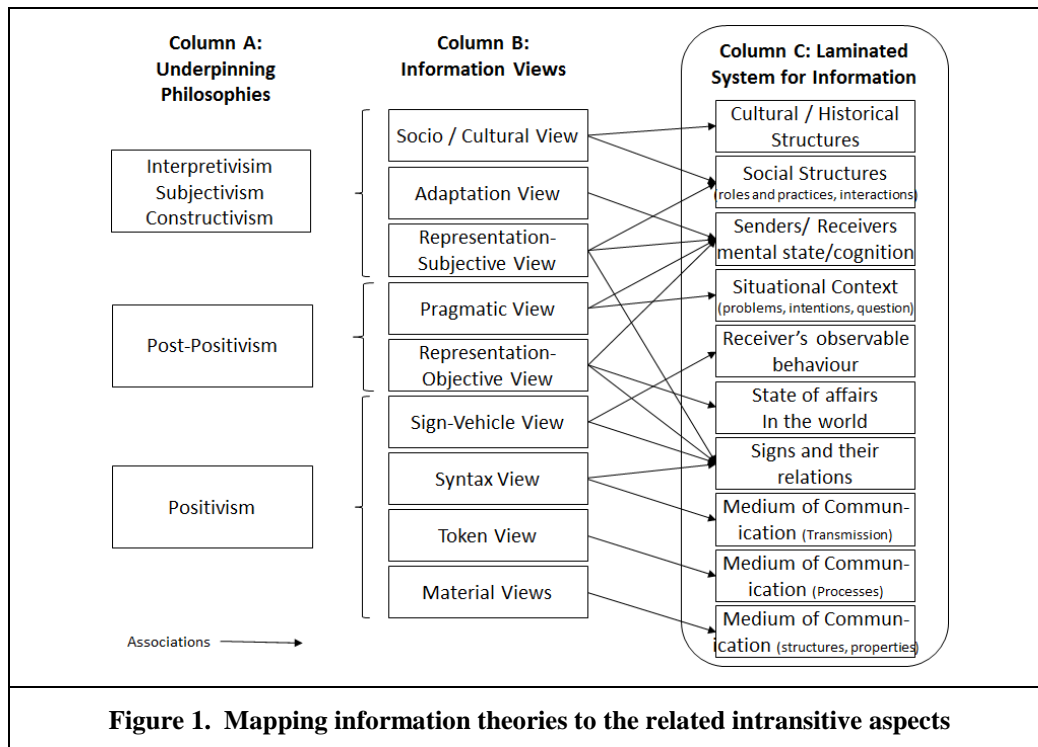
The material view or the physical stance on information (Boell 2017), defines information as "the pattern of organization of matter and energy" (Parker 1973, p.10). The example of a theory of information in this view is based on the concept of thermodynamic entropy (Stonier, 1990) (see Table 1). The Material view adheres to positivist ontological assumptions, thus within this view as argued by Boell (2017), information exists independent of human perception and the focus is mainly on the structures and properties of the material world. While the relevance of this view to IS studies is limited, it addresses an important aspect of information; the physicality of the communication medium (Houston and Harmon 2002). Harmon (2002) defines information as a summation of mass, distance and electrical charge, as the characteristics of physical medium of communication. Thus, the material view is able to provide explanation about the physical structures and the properties of the communication medium. In Critical Realist terminology, we can say that the focus is on the causal mechanisms related to structures of the medium of communication.

The token view is focused on processed data as input and output in mind, machine or organization (Losee 1997; McKinney and Yoos 2010). The token view emphasizes processes in defining information (Boell 2017; Losee 1997) (for example, a purchase order creation requires recording a purchase, validating, storing and retrieving the tokens). The token view is valuable in understanding data processing in computers and organisations. However, it does not differentiate between data and information and gives limited consideration to the role of human perception in the definition of information. The Token view, based on positivist ontological assumptions, defines information independent of human perception. Theories within the token view are able to provide explanation for processes within the physical medium of communication.

The syntax view defines information as measurable relations between tokens (McKinney and Yoos 2010); signals transferred between the sender and the receiver (Boell 2017), and can be applied across a wide variety of topics. A central theory in relation to the syntax view is the mathematical theory of communication by Shannon and Weaver (1949). In IS, this view is used when studying relationships across data attributes and designing databases (e.g. Korn 2001). This aspect, although useful, does not consider any meaning about the tokens and is concerned with signal transmission rather than information (Boell 2017). The syntax view, also defines information independent from the human observer, and is based on positivist ontological assumptions. Information theories within the syntax view focus on the communicated signs and their measurable relations and the transmission capabilities of the communication medium.

Viewing information as sign-vehicle, defines information as a thing contained in the sign-vehicle (Buckland 1991) or any physical representation of the knowledge or thoughts (Farradane 1979). Farradane considers both originator and recipient of information and suggests that such a definition of information provides a positivist starting point for construction of information. He suggests there is no method to discover the origin of thoughts (sender's intention) behind information and only "the ultimate effects of communication" in terms of the recipient's observable actions, can be examined (Farradane 1979, p.13). This approach thus aligns the sign-vehicle view of information with positivist ontological assumptions. Considering Farradane (1979), we argue the sign-vehicle view is able to explain signs (physical representation of knowledge) and also attends to observable behaviors of the recipients.

The representation-objective view of information is based on the belief that objective reality exists and "a representation includes a sign, an object and an observer" (McKinney and Yoos 2010, p.334). Information in this view is defined as a model of objective reality. In Dretske's definition "signal r carries the information that S is F, if the conditional probability of S's being F, given r (and K, the prior knowledge of the observer) is 1" (Dretske 1981, p.57). This definition suggests that "information is the propositional content of a sign"; that is, the state of affairs required in the real world for those signs to exist (Mingers 1995, p. 290). In other words, information is the regularity between signs and objects (McKinney and Yoos 2010). Dretske (1981) then argues that the transformation of information to meaning is happening through 'digitalization of analogue'. While our experiences (such as lights from a scene triggering our retina) are analogue, 'meaning' (what we can see in a particular scene) is progressive digitalization of this experience (Dretske 1981). According to this view, through digitalization, objective information is converted to subjective meaning (Mingers 1995). This differentiation between objective facts and subjective meaning, aligns Dretske's philosophical position with post-positivism. For the under-labouring purpose, Dretske's theory, thus, firstly by defining information objectively, points to the state of affairs in the real world given the sign (or change in the state of affairs), and secondly, by defining meaning, points to the receiver's mental state and cognition. Dretske's (1981; 1983) definition of information provides a clear distinction between signs, information and meaning and describes the relationship between sign and information clearly. Dretske's definition, although compatible with Information System studies and other disciplines such as social theory and organizational behaviour, provides less precision when it comes to the social and cultural nature of information (Mingers and Standing 2017).

The pragmatic view, defines information as the relevant knowledge which is needed in a problem solving situation (Fischer 1993). This view of information is concerned with the receiver's intention but does not define information as a mental concept. In this view, information is something that can be assessed and compared in relation to what is required (Boell 2017). In terms of philosophical position, and considering the illustrative theories (Fischer 1993; Taylor 1986) representing this view of information (Table 1), this view is closer to post-positivist beliefs. From a CR perspective, this view of information is more concerned with the recipient's intentions, specific problems and questions.

A representation-subjective view of information marks a paradigm shift from the objective views of information above. Information in this view is defined in relation to the recipients and the meaning they perceive, or the change in the recipient's knowledge. Within the representation-subjective information view, two exemplar theories are identified; Checkland's (1998) definition of information as data plus meaning, and MacKay's (1955; 1961b) definition as the change in recipients cognitive structure caused by meaning. Both Checkland and MacKay, provide subjective and semantic accounts of information (Mingers and Standing 2017). Checkland's approach stems from a phenomenological position, thus relates information and knowledge to humans' mental state (Mingers and Standing 2017). Checkland's definition of information thus points to the recipient of the message and their mental state and data, yet remains vague in defining data and differentiating between meaning and information (Mingers and Standing 2017; Mingers 1996).

MacKay's definition of information as change in receiver's knowledge (MacKay 1961a) or change in receiver's cognitive structure (MacKay 1961b) relates information to 'state of readiness' of the recipient (MacKay 1961a; Mingers 1996). MacKay is mainly focused on communication through language, and differentiates the sender as the one who wants to transmit a meaning, the message as the carrier of meaning, and the receiver who is in a "particular state of readiness" (Mingers 1996, p. 199). MacKay's theory is well developed, especially in linking information to social interactions and social theories. However, this definition is totally subjective, and doesn't clarify the link between information and data or between

information and the physical world (such as its transmission, storage or processes) (Mingers 1996). MacKay's definition of information has been criticized for being complex and for ignoring the processes and practices that enable, generate and reproduce cognitive representations (Healy 2005).

The adaptation view of information is based on subjectivism; a nominalism philosophical ontology that rejects the existence of reality independent of human's perceptions and defines information as a creation by the informed (McKinney and Yoos 2010) or "mental shaping process of an informee" (Boell 2017, p.16). Illustrative theories using adaptation view (McKinney and Yoos 2010) include systems theories such as autopoiesis (Maturana and Varela 1980). The adaptation view of information is mainly focused on the informed's (receiver's) systems. Furthermore, its ontological assumptions constrain the capacity of this view (and the related theories) to consider the influence of social forces on the information receiver's perceptions and behavior.

Finally the social/cultural view, defines information as a social construct formed based on social and cultural structures. Information in this view is dependent on social positions as roles, and social practices.

Figure 1 represents the above discussion, showing that by distilling the philosophical underpinning (column A in Figure 1) of information views (Column B in Figure 1) we can map these views to different intransitive objects (Column C Figure 1). By mapping the information views and related information theories (Column B) introduced above, to different entities and structures to which they are pointing (Column C), this study recognises a stratified view (laminated system) for information (Column C), consisting of the medium of communication structures, processes and transmission; signs and their syntactic relations (data); state of affairs in the real world; receivers' observable behavior; situational context; sender/receiver mental state; social context; and cultural and historical context.

Defining a laminated system of information implies that each theory of information provides an important indicator to significant structures and mechanisms interplaying at different levels[4], forming the information phenomenon. Different theories based on different paradigmatic assumptions provide insights to some aspects of information. Thus, from a CR perspective they aren't contradicting but rather complementing each other (Bhaskar and Danermark 2006). Information however, cannot be reduced to any singular and bounded level of understanding. To understand how these information theories are related to each other in a complementary manner (an interdisciplinary knowledge of information phenomenon) the effects and interactions between these intransitive aspects should be explored.

Stratified framework of Information (Interdisciplinary foundations)

To achieve an interdisciplinary definition of information, one needs to consider impacts of the intransitive levels and their causal interactions (Bhaskar, 2010). To find out how the identified levels in Figure 1 are interacting, this study relied on Mingers and Standing's (2017) information theory, based on Dretske's (1981; 1983) definition of information, and also CR domain stratification tenet. Figure 2 depicts the resultant stratified framework of the concept of information, the logic of which is developed in discussion following.

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[4] *"Level announces an emergent whole with its own specific determinations capable of reacting back on the materials from which it is formed"* (Bhaskar 1986, p. xiii). Bhaskar's ontology is based on belief in the stratification of the intransitive world into levels (Elder-Vass,s 2007). This is different from level of analysis which refers to the conceptual entity under theoretical and empirical investigation – e.g. individuals, groups, organizations discussed in multi-level theorizing (Zhang and Gable 2017).
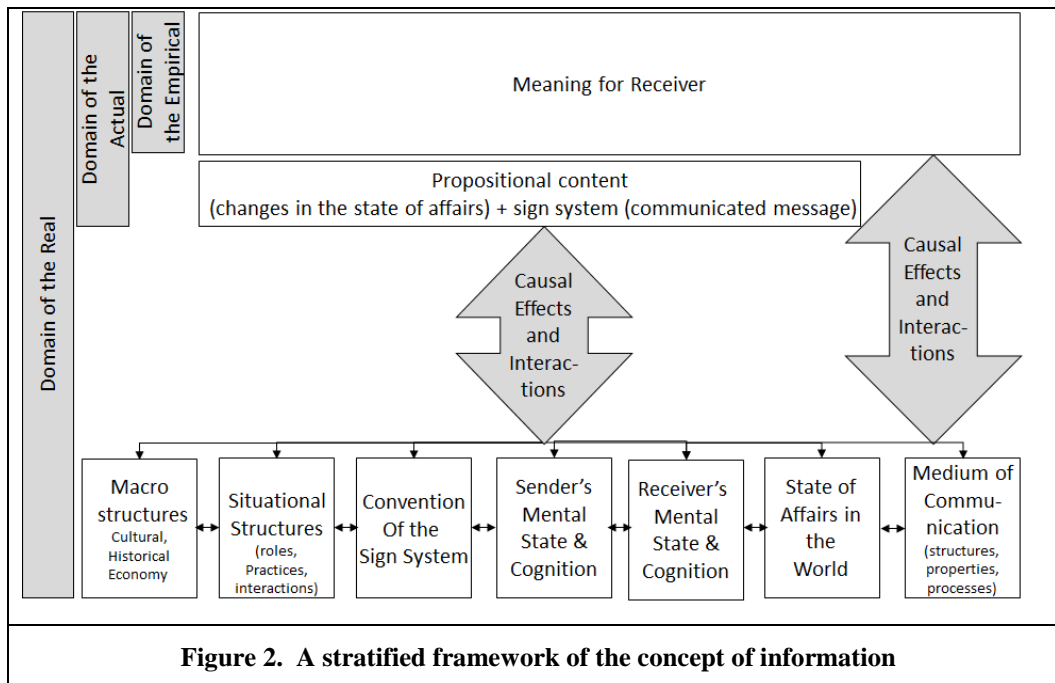
Figure 2. A stratified framework of the concept of information

Mingers and Standing (2017) theory of information (following from Mingers (1995) conception of information) draws on Critical Realist principles consistent with Bhaskar (1998) and assumes the existence of a physical world consisting of structures, entities and events that are related in causal ways. Mingers (1995) draws on Dretske (1983) to build his conceptual model of information. He defines information as the veridical objective propositional content of sign systems, and clearly differentiates between the terms 'data', 'information' and 'meaning'. Mingers' makes two main additions to Dretske's definition, which make his definition more comprehensive. First, is his description of the meaning generation process (semantic meaning) in the users' mind, for which he refers to autopoiesis theory (Maturana and Varela 1980), and which provides a biological explanation for the cognition process. Second, he describes the social aspect of meaning generation and language, relying on the work of Habermas (1984). These additions provide theoretical description of possible interactions between different levels in Figure 1 (how information is converted to meaning through different stages, thus, providing explanation for interactions between the sign, the state of affairs, the receiver's cognition and social structures). Most importantly, the differentiation between signs, data, information (propositional content) and meaning in Mingers and Standing (2017), in conjunction with CR's domain stratification, helps to position the intransitive levels identified in Figure 1 in relation to each other. Below, the terms; sign, data, semantic information and meaning, consistent with Mingers (1995) and Mingers and Standing (2017) and how these terms have been used in Figure 2, are described.

<u>Sign</u> is defined in Mingers (2017; 1995) consistent with Peirce (1931-1958) as "a representamen" which is "something that stands for somebody or something in some respect or capacity" (Peirce 1931-1958, p. 9). In Figure 2, the term sign is used consistent with Pierce and Mingers' definition.

<u>Data</u> is "a collection of signs, usually brought together for some purpose, to store or transmit information" (Mingers and Willcocks 2014, p. 58); it can also be called a 'sign system'. In Figure 2, we use the term communicated message instead of data, assuming a message in any communication process is composed of data or sign systems.

"<u>Information</u> is the true or veridical propositional content of data and signs"; it's the difference in the state of affairs in the world that implies existence of the signs (Mingers and Willcocks 2014, p. 58). For example, the ringing of a doorbell carries information about the cause of the doorbell ringing that could be either - someone is at the door pressing it, or the information that there is a fault in its electrical system. In either case the propositional content of the doorbell's ring is true, pointing to its cause. In Figure 2, we have avoided the use of the term information intentionally, to not impose any definition of information.

However, the causal relationship between the propositional content, sign and meaning is adapted from Mingers' (2017; 1995) definition.

<u>Meaning</u> is defined as a subjective and inter-subjective concept (Mingers 1995). Meaning is dependent on an individual's (receiver's) interpretation, their prior state (i.e. their experiences and knowledge-base), their connotation system, and their intention. In Figure 2, the term meaning has been used consistent with Mingers' definition.

Having the above definitions, CR's depth ontology assumptions (reality exists in three domains; empirical, actual and real) help to position the intransitive levels of information theories in Figure 1 in relation to each other. Consistent with Bhaskar (1993), the propositional content or the change in the state of affairs given the sign has occurred (Information in Mingers definition) and the sign system (a message in a communication process), exist in the domain of the actual. When the message or signs are observed and perceived by a recipient through their cognition process, meaning and subsequent observable behaviors are formed which belong to the domain of the empirical (Mingers and Willcocks 2014) (see Figure 2).

According to CR, the real domain consists of structures and entities that are interacting to create events which can be observed or not. The real domain structures in relation to the concept of information, form the changes in the state of affairs and the signs in the domain of the actual, and also meaning perceived by the information recipient and their consequent behavior in the domain of the empirical. Humans can never experience these changes in an unmediated way; they is literally inaccessible; humans are always in the world of interpreted meaning or in the empirical domain.

To identify these structures and to better clarify Figure 2, two examples of the communication process - one in relation to information system and one in the broader context, are elaborated following.

To start, we look to a non-IS related example; smoke coming from a forest seen from a distance by an observer. The smoke itself in this example is the sign and the message (in the domain of the actual) with possibly different connotations (thus meaning) for the **observer** (receiver) which are formed through social structures of the situational context; it could represent a potential bush fire (if the observer knows the area has a history of bush fires) or it can represent someone in the forest asking for help. The meaning the observer gets from observing the smoke and their consequent action, thus is dependent on the context and the related connotation of the smoke as a sign in the **socio/cultural structures**.

The propositional content - the smoke, the actual fire however could be either a bush fire or a person making fire to ask for help. In this example, the heat and the situation (level of humidity) to cause a bush fire, are state of affairs in the real domain. If the fire is made by a lost person in the forest, the person (**sender**), their **intentions** (formed through interaction with situational structures), their access to material to make a fire (**communication medium**), are states of affairs in the real domain that could cause a fire and smoke observed by someone. This example, shows that receivers of the message, their intention, socio/cultural structures (connotations), and social structure of the situational context are real domain structures interacting to form the meaning and behavior of the observer. The cause of fire - the sender, their intentions, their access, or the heat and humidity (**state of affairs**) could be considered as real domain structures, creating a message and potential meaning perceived.

In the IS context, this positioning can also be illustrated by an example from social networking websites. It could be argued that on a social networking website, users' ratings of the content is a sign which carries information and possibly meaning for the recipient of the content. In this example, the social networking website itself is representing the medium of communication. The functional features (such as what kind of rating system it provides, and how users have access to that, etc.) are **properties and structures** of the **medium of communication**. These properties and structures however are in interaction with social structures (Mingers and Willcocks 2014) which might alter both creation of a message (in the domain of the actual) or the meaning perceived from it (in the domain of the empirical).

The receiver's understanding and awareness of **social norms/culture** and **connotation** related to the rating function (e.g. likes in Facebook) represents the interaction between the receiver and the socio/cultural structures in the domain of the real which are influencing the meaning perceived. The receiver's **personal experiences** and use of the communication platform within the **social structures** of the **situational context** also can change the meaning they perceive from users' ratings; for example, in Facebook as the communication platform (Mingers and Willcocks, 2014).

The high rating (e.g. number of likes) for specific content and the intentions behind that, belongs to the domain of the actual. For example, the propositional content of high ratings could be that the author of the content is a popular person or the content itself is valid and reliable (domain of the actual). Different users might have different **intentions** formed by their **situational context** or **wider social and cultural context** when rating content on a social network website. Thus, the propositional content of the message is formed through the interactions of these structures in the domain of the real.

Based on the above example, this paper, proposes a stratified framework, which identifies the intransitive objects in studying information, and their interactions (Figure 2). Based on the above examples we combine the bottom three levels of Column C in Figure 1 into Medium of Communication (the structures, the properties, and the processes of the communication medium). This approach provides better opportunity to investigate the communication medium as a structure and its interaction with other structures as well (in future research this aspect might be further decomposed into other sub-structures). As evident from the above example the communication medium can include anything, from the non-technological to an information system within organizations. We also differentiate between three different social structures because of the specific role of these structures in the communication processes; and (i) macro social structures including culture, history and economy (Layder 1998); (ii) connotation system as a socio/cultural structure (Mingers and Willcocks 2014); (iii) social structures of the situational context consisting of roles, practices and interactions State of affairs can relate to any other contextual situation that cannot be described through the interaction of the social, the individual (sender and receiver) and the communication medium structures.

In describing the interactions and the structures through the above examples, we intentionally avoided using the term information. It is true that different research with different intentions can use the term information to refer to different aspects of the suggested model. However, the framework suggests that researchers, with any use of this term, need to be able to first, position their definition in relation to the structures and their aspects of interest, and second, acknowledge the other structures and possible interactions. Thus, the suggested framework provides the potential of an interdisciplinary body of knowledge for information studies (theories and studies on information). This approach also provides a reflexive lens in selection of research questions and research methods when using the term information with different research foci. Next we discuss the implementation of such a multi-level framework for studying information quality.

Discussion

This paper proposes a meta-theoretical framework derived from reflection on theories-in-use about information (Lee, 2010), and intended as a foundation for interdisciplinary research. In this section, we use the two research streams: (i) information quality and (ii) data quality, to demonstrate the role of the proposed framework in positioning these two streams of research relatively, and suggesting other implications of the framework for these quality studies.

It seems obvious that any attempt to conceptualize Information Quality (IQ) must be built on a clear conception of 'Information'. However, IQ research (like other areas of IS research) has skirted this central concept. Most IQ researchers adopt a quasi-operationalist approach to conceptualization, focused on measures and dimensions, using the terms data and information interchangeably, and seldom explicating any precise definition (Mai 2013).

The first implication of the proposed framework is in relation to the term 'quality'. Although this study agrees with Reeves & Bednar (1994), who argued that the quality of any product or output should be defined by considering the nature of that product (e.g. whether information or data), they also note that quality cannot be defined independent of a quality evaluator (Carr et al. 2001). Considering this view of quality, the quality evaluation in any communication act is related to the recipient's perception, and thus, only happens in relation to meaning or the empirical domain in Figure 2. This is consistent with Mingers' (1996), where he describes how propositional content of a message, in the domain of the actual, is always considered as 'true' independent of the observer's perceptions. Judging the quality of the propositional content can only happen once it has been transformed by users into a meaning which is generated by the users' cognitive process on receipt of a message (see Figure 2). This implies that in any situation, with any definition of information or data, quality is what is perceived by the recipient of the message or sign, in the mind of the

receiver. The receiver could be the end-users of information systems, the researcher, the designers of the information systems, or data analysts. This understanding doesn't mean that other definitions of information quality or data quality are not relevant. For example studies focusing on data quality are investigating one aspect of the structures (syntactic rules and conventions of the sign system) important in forming the concept of quality from the view point of a specific group of users (could be end users, or database designers or data analysts). Or, studies focusing on quality in relation to context and users (fitness for use), are focusing on the social and situational structures in forming the concept of quality.

Another implication of this proposed framework is in relation to the Mingers (1996) argument that the propositional content of the message or the sign system is always true. This has implications for data analytic studies and big data. Data quality of the data sets retrieved from various information systems has been one of the growing concerns of data analysts (LaValle et al. 2011). Accordingly, different data cleansing methods and algorithms have been developed to deal with quality issues and to provide data sets that can be used by analysts and analytical tools. According to the proposed framework (Figure 2), data cleansing methods are dealing with syntactic aspects (connotations) of the data set, or what we refer to as the 'message'. These tools try to identify syntactic problems in a data set and resolve these before using data for analysis purposes. The goal of data analytic studies is to gain insight about the real world structures (especially social and cultural and their interactions with other structures) through analyzing the big sets of data provided. As discussed, the sign system or message and the propositional content of these are representing the interactions between different structures in the domain of the real. Data quality issues (as it has been referred to in data analytics), thus, are representing the real state of affairs related to the structures in the world. Therefore, by removing these issues from the data set using automated data cleansing methods, data analysts are even more restricted and biased in terms of their access to discovering the reality. The actual cause of data quality issues, in relation to social or communication structures, should be investigated before any attempt to sanitize these issues in data sets.

The study reported has limitations. The framework proposed in this study, based on CR's tenets, does not aim to propose methods for studying the information phenomenon. Rather, CR being a philosophy for science, provides the tools to understand science. The investigation of appropriate methods is not within the scope of this framework and requires further scientific investigation. The framework presented is based solely on existing scholarly work and conceptualizations of information in IS studies. Further, the information theories and their classification into views in this paper is heavily grounded in the prior work of a small number of others, particularly in the work of (McKinney and Yoos 2010) and (Boell 2017), which too is fallible. The framework is tentative, likely incomplete, and will change. It is worth revisiting periodically to take account of new views that have developed, and related new levels that can be uncovered.

However, we argue that the study framework goes further than prior work, by acknowledging different aspects of the knowledge base and how they are interacting together. The proposed framework not only provides the opportunity for interdisciplinary work between data quality and information quality studies but also further contributes to interdisciplinary work within the IS community to define other concepts in relation to information. For example, researchers interested in the principles of designing IT artifacts can position their work (and work with) in relation to behavioral research that studies the use of technology and also in relation to studies on social aspects of technology. Such an interdisciplinary approach offers promise of research results that are stronger for solving real world complex problems (Bhaskar 2010; Choi and Pak 2006).

The proposed framework can be further developed through theoretical investigation, using existing work (e.g. Mingers and Willcocks 2014; Mutch 2010) to better frame the structures and their interactions. Several of the interactions (in Figure 2) were not discussed in this paper, but nevertheless they exist and further clarification of their effects is required in future work. Other avenues could be, implications of the framework in data analytics studies, and identifying possible patterns of data quality issues in relation to the structures in the domain of the real. This can result in the development of more informed data cleansing methods and more insightful data analysis.

Conclusion

With the advancement of technology and the emergence of new information sources, information quality researchers have been facing new challenges. To be able to address these challenges, this study aimed first to develop a conceptualization of the term information.

The concept of information being a pivotal term for both IQ research and IS studies has been taken for granted for many years. Accordingly, several IS scholars have attempted to bring more clarity to this concept among them Stamper (1991), McKinney and Yoos (2010), Mingers (1995; 1996), and Boell (2017). One of the main debates regarding definition of information evident in these works is the possibility of a unified definition of information, which has been advocated by Mingers and Standing (2017) and opposed by Boell (2017) and McKinney and Yoos (2010).

This paper takes a different position, which while believing that a unified definition of information is not achievable, aims to develop an interdisciplinary framework to study information. The interdisciplinary approach provides the possibility of positioning different knowledge of the phenomenon, in relation to the stratified ontological definition of the term, to avoid a reductionist approach.

To develop the stratified ontology of information as the basis of interdisciplinary research, this paper relies on the ontological assumptions of Critical Realism to examine the philosophical and ontological assumptions of existing theories of information and to explain the emergent nature of this phenomenon.

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