# Practical and Philosophical Considerations for Defining *Information* as Well-formed, Meaningful Data in the Information Sciences

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## Abstract

This paper demonstrates the practical and philosophical strengths of adopting Luciano Floridi's "general definition of information" (GDI) for use in the information sciences (IS). Many definitions of *information* have been proposed, but little work has been done to determine which definitions are most coherent or useful. Consequently, doubts have been cast on the necessity and possibility of finding a definition. In response to these doubts, the paper shows how items and events central to IS are adequately described by Floridi's conception of information, and demonstrates how it helps clarify the muddy theoretical framework resulting from the many previous definitions. To this end, it analyzes definitions, popular in IS, that conceive of information as energy, processes, knowledge, and physical objects. The paper finds that each of these definitions produces problematic or counterintuitive implications that the GDI suitably accounts for. It discusses the role of truth in IS, notes why the GDI is preferable to its truth-requiring variant, and ends with comments about the import of such a theory for IS research and practice.

## Introduction

In this paper, we defend the notion that Luciano Floridi's "general definition of information" (GDI) is an attractive definition for use in the information sciences (IS). This defense is carried out by demonstrating the theoretical and applied advantages of the definition; we discuss several common items and events of concern that are adequately described by the GDI, as well as analyze how it helps to clarify the theoretical framework resulting from the many previous definitions.

Within IS, including informatics and library and information studies (LIS), it is generally agreed that the theories of the field should be able to

cogently describe what exactly *information* is. Much work has been done toward this, including attempts to understand information through both broad characterizations and formal definitions. Many definitions have been created intending to meet the theoretical and practical needs of IS. More definitions still have been advanced for uses in other fields, and some of these have been examined with interest by IS theorists for possible appropriation into the theory of our field. Yet, it is unclear which definition is most coherent or useful, as little work has been done to determine this. As the resulting theoretical picture is unclear, doubts have been cast on the necessity of a definition at all and also on the possibility of a satisfactory one.

In response to such concerns, we argue that a satisfactory definition of *information* is desirable and that the GDI is tenable for use in IS. Rather than simply examine yet another definition of information, we demonstrate how this conception helps us to understand the theoretical picture produced by previous definitions. We identify where several popular definitions fall short by critically comparing Floridi's views to those that influenced IS before it. To demonstrate the practical use of his views, we use it to explicate several examples of items and events that commonly concern IS, which should make the definition palpable. We then discuss why the GDI is better suited for use in IS than its truth-requiring variant, the strongly "semantic definition of information" (SDI). We end the paper with comments about the import of such a theory for IS researchers and practitioners.

## Previous Definitions of Information

Several reviews of definitions, characterizations, and conceptions of information have been given, ranging from article-length syntheses (Bates, 2005; Budd, 2011; Furner, 2004b; Karamuftuoglu, 2009; Kaye, 1995; Madden, 2000; McCreadie & Rice, 1999; Qvortrup, 1993; Rowley, 1998) to comprehensive, chapter-length surveys (Bates, 2010; Bremer & Cohnitz, 2004; Capurro & Hjørland, 2003; Floridi, 2004d, 2010a; Furner, 2010; Ramage & Chapman, 2011). Such reviews vary in their comprehensiveness of definitions and inclusivity of various relevant fields, but most start in the 1940s, with Shannon and Weaver's mathematical communication theory (MTC). MTC is an approach to formalizing and quantifying information as it features in acts of communication (Shannon & Weaver, 1948; Weaver & Shannon, 1949). The development of MTC also served as a backdrop for the creation of two other movements to characterize information: the "probabilistic semantic" view characterizes information as meaningful content in a probabilistic space, where there is an inverse relation between the amount of information in some event $p$ to the probability of $p$ (Bar-Hillel, 1964; Bar-Hillel & Carnap, 1953; Dretske, 1981); the "systemic" view characterizes information as states of space and

consistency in some system (Barwise & Perry, 1985; Devlin, 1995; Israel & Perry, 1990).

Together, these three views can be thought to comprise a physics of information and are still used fruitfully in applications of communications theory, technology, and mathematics. These views can be grouped with the conceptions of information used, often implicitly, in biology, computer science, and physics: such conceptions aim to quantify information, often so that it may feature in formal equations[1] rather than aiming to strictly identify its nature in terms of necessary and sufficient conditions.[2] Perhaps as a consequence, MTC and its contemporaries are no longer emblematic of the views of information held by IS researchers and professionals; rather, these accounts have been joined by many definitions and characterizations that have since been suggested and advanced. As a start, here are several accounts intended for use in IS, put briefly. Information is

- a difference that makes a difference (Bateson, 1972);[3]
- that which changes a knowledge structure (Brookes, 1980);
- a thing, process, or knowledge (Buckland, 1991);
- an evolutionary process (Fleissner & Hofkirchner, 1996);
- that which describes a process, its input, and output (Losee, 1997);
- a stimulus from one system that affects the relationship between itself and another (Madden, 2000);
- a continuum of data that has been assigned meaning (Herold, 2003);
- evidence (Furner, 2004a);
- the pattern of organization of matter and energy (Bates, 2005);
- the same pattern, once assigned meaning (Bates, 2006);
- the recorded counterpart of true propositions; weak knowledge (Frické, 2009);
- meaningful communicative action that aims at truth (Budd, 2011); and
- a sign (Mai, 2013).

Still more definitions exist, ranging from complex mathematical formalizations to quotidian ambiguities and trivial truths. (See Bates [2005] for over twenty additional definitions; Zins [2007] for definitions based on the impressions of forty-five IS researchers; and Sommaruga [2009] for many formalizations.)

Despite the impressive number of definitions, it remains unclear what they individually or collectively allow us to confidently say about information. Definitions are rarely presented with examinations of how they overlap with or contradict other definitions, and surprisingly little direct disagreement and debate about the definitions has occurred among IS theorists. This problem is well-illustrated by Schrader's (1983) expression of frustration at the multiplicity of vague and bizarre definitions of information available as early as 1983. Meadow and Yuan (1997) offer a rare attempt to organize and interrelate many previous theories, but

these theories have since been joined by two decades of additions. As with the many models of information behavior, one could say that the field suffers from a "many definitions problem": a concern for the diminishing value of each new definition could be reasonably expressed, and sense needs to be made of the overall picture. That the many definitions together produce an unclear theoretical picture would be true even if every definition given was perfectly adequate for its intended uses, although we argue below that such is not the case. Both the cause and seeming effect of this unclear picture is that there is a lack of consensus in IS about how to define information.

In light of this unclear theoretical picture, as well as the difficulty of reaching a satisfactory definition of information, some authors doubt that a suitable definition is possible, and some argue for abandoning the effort altogether. This option deserves consideration, so we turn to it next.

## Is a Definition Possible, Necessary, or Desirable?

To sufficiently define *information* has challenged not only IS, as we have noted, but many other fields, and these challenges have lead to doubts that a satisfactory definition is possible or necessary. The broad doubt is that a discipline-independent definition or "unified theory of information" (UTI) could define information sufficiently to be used in any field or context. Is a UTI possible? Is it possible for a conceptual analysis of information to give us necessary and sufficient conditions that satisfy the constraints of all the various fields in which information features? As interesting as this question is, it may not benefit IS—primarily an applied discipline—to wait for such an account to come along, as defining satisfactorily such fundamental ideas is notoriously difficult. For example, the debate in epistemology about a definition of *knowledge* is still not settled: although knowledge has been examined for over two millennia, the standard definition was successfully overturned just fifty years ago (Gettier, 1963). Given the various applications of the concept of information, it too may be reasonably expected to be subjected to a long and winding analysis. It is possible that if philosophers could reach consensus on how to define information, such a definition could be broad enough to be discipline-independent and satisfactory in any context. Consensus of any sort is rarely reached in philosophy, however, and so the prospects for a UTI are bleak. Deeper analyses of the challenges of finding a UTI are given in Capurro, Fleissner, and Hofkirchner (1997); Fleissner and Hofkirchner (1996); Losee (1997); and Sloman (2011).

The more worrisome doubt is that IS should bother to define information for its own purposes. Given the success and adoption of MTC, we find it uncontroversial to conclude that field-dependent definitions of information are possible, and we later identify one for use in IS. Some IS researchers, however, have been challenging the necessity of such a defi-

nition; even Brookes (1974), despite his efforts to conceptualize and formalize a definition of information, eventually encouraged the field away from a strict definition and toward a more relaxed use of the term. Two further similar sentiments have followed.

Furner (2004b) suggests that the definition project is not necessary, and to demonstrate this, he describes thoroughly the field of IS without any recourse to relying upon a definition of information. How much are we to conclude from the fact that a field can be described by drawing on the language of other fields? We find this question hard to answer with confidence. Prima facie, it seems plausible that many fields may be adequately described in a similar manner—that is, without recourse to some concept that is a prominent phenomenon. Despite this, it is evidently useful to rely upon and utilize such concepts. For example, prior to Bolzano and Cauchy, no rigorous definition of *convergent series* was available; mathematicians knew that certain series converged, but could not produce a general, formal demonstration (Cleave, 1971; Grattan-Guinness, 1970). When Bolzano and Cauchy provided a rigorous definition for convergence, mathematics and physics advanced and important further formal definitions (for example, the root and ratio tests) were then established (Knopp, 1956). Many common theorems in use today would not exist or be provable if a suitable definition had not been produced. Similarly, the interpretation of the results of experiments depends heavily on definitions of key concepts. With one definition of *freedom of the will*, it can be argued that the results of neuroscience experiments imply that there is no such thing as free will; with another definition, free will is tenable (O'Connor, 2009).

The consequences of having no definition are not hard to imagine for IS. Consider a case study meant to identify the information provided by a reference librarian. What should be counted as information for the purposes of such a study? Is a blank piece of paper, given to a patron for note-taking, to be counted? Is a provided internet URL to be counted? What of a book of poetry? Suppose a book is provided by the librarian, but the patron has already read it very closely: Does this count as information provided? The answers to these depend on the definition employed, and so the data collected and the findings also depend on the definition.

An interesting point to be gleaned from Furner's (2004b) thesis is that it is more convenient to describe our field without reference to information than it is to actually define it. Although convenient, this simply shifts the problem onto other fundamental concepts; for example, in describing information-less IS, Furner makes reference to *data*. Data are generally considered to be the base of the data–information–knowledge hierarchy and feature in many accounts of information (Frické, 2009). By using data to describe the concerns of IS, he illustrates not only the usefulness of the term but also the necessity of fundamental terms.

Hartel, Pollock, and Noone (2013) provide an additional critique to the tradition of defining information. Motivated by perceived short-comings of the previous attempts to understand information by means of propositions and analysis, they embark on an arts-informed, visual approach to understanding information by analyzing 4-by-4-inch drawings produced by iSchool graduate students when asked "What is information?" In justifying their project, Hartel and colleagues note that previous definitions share shortcomings because of their approach: they are scholarly and therefore narrowly drawn, word-based in a multimedia society and therefore inaccessible, and singular in their perspectives. Hartel and colleagues' project, by contrast, is intended to be egalitarian and visual and embrace many perspectives on information.

Examining common parlance and thought seems an intuitive way to begin understanding how to broadly characterize a phenomenon, and their study identified many examples of the various common perceptions of what information is. However, that there are many technical and philosophical definitions of information available demonstrates that discussion of how to define information has moved beyond the point of characterization, and this is why the "shortcomings" that Hartel and colleagues have identified in the previous literature can hardly be called such: deep, critical understanding requires conceptual analysis, which necessitates words, scholarship, and identifiable theses. This is particularly true for the analysis of a concept like information, which has proven so difficult to adequately define.

Despite the difficulties and doubts surrounding defining information, many definitions have been advanced, and the analysis of what information *is* continues. Through the considerations stated here, we believe a definition that is useful and theoretically rigorous is desirable; we also believe that one is available, as we will now discuss.

## A Semantic Conception of Information

Semantic conceptions of information view information as being composed of meaningful content. There are several such conceptions, which appear in various forms in works by Bar-Hillel and Carnap (1953), Dretske (1981), and Floridi (2004c, 2005). For detailed introductions to the nuanced differences of various semantic conceptions of information, see Floridi (2011b). Of these views, the one that concerns us here is developed by Floridi and specifically characterizes the content of information as well-formed and meaningful data. He has argued that such a conception is particularly appropriate for IS, citing the applicability of the philosophy of information (PI) as a foundational grounding for IS (2002, 2004a), although not without resistance (for example, Cornelius, 2004). Examples of recent research topics regarding Floridi's view of information include formalizing it (Allo, 2008), examining its implications for

precognitive processing (Vakarelov, 2010), and examining its implications for verificationist theories of truth (Floridi, 2011a).

This conception has resulted in two definitions of information, called the "general definition of information" (GDI, although sometimes it is called the "standard definition of information," which may cause confusion with the following acronym) and the "strongly semantic definition of information" (SDI, also sometimes called the "specific definition of information") (Floridi, 2004c, 2005). Since both the GDI and SDI rely upon a definition of data, it deserves some attention before we move on.

Both definitions hold a diaphoric definition of data: data are differences. A single datum can thus be understood as a single value or set of values: for example, the state of something being on, the color red, a particular person named Kevin, the time 12:00 PM, a stretch of time from 12:00–5:00 PM, the text "12:00–5:00 PM" that refers to that stretch of time, some particular glass, glasses in general, the geometric concept of a circle, pain, the words *president* and *that* (for example, as an indexical), three hundred, the blinking of a light, smoke, and so on. The examples of data given here carry conventional meaning, whether we consider them as words or as the actual instances in the world that the words refer to, but data may not always be meaningful: "F33R" is an instance of data, despite having no intended meaning. *Red* is identifiable as red, in contrast to and as different from nonred values. It is a feature of data that they provide constraints and affordances, allowing and disallowing various information, such as conclusions, to be gleaned from or made with them. Generally speaking, this definition of data matches our intuitions about them that are revealed by general uses of the word in IS practice, such as when referring to recorded data like the values in a spreadsheet cell ("$5") or database property ("Yes").

With data thoroughly defined, we can now examine the two definitions of information produced by Floridi's view of information as meaningful, well-formed data, which we are here endorsing for use in IS research and practice. Although the above examples and explanations are our own, the definitions are taken from Floridi (2010a, p. 19), where they are explained at greater depth. The GDI defines *x* as information if and only if

GDI.1: *x* consists of one or more data;
GDI.2: the data are well-formed; and
GDI.3: the data are meaningful.

The first criterion requires that there be present at least one datum, understood as we have described above. The second requires that any present data be well-formed—that is, present together in a way that adheres to the rules that govern a system or language in which they feature, such as rules of syntax in a spoken language or programming language or the spatial rules governing a 3D virtual environment. The third criterion requires that

the data be meaningful: that they offer semantic representation according to the system from which they are derived; in the English language, "*trois cents*" is not meaningful, but "three hundred" is. Of the examples of data given above, some data may additionally be information in certain circumstances; for example, "12:00 PM" as an answer to a question about time or even simply "Hello," as they form complete and meaningful sentences. The words *that*, *dog*, and *black* are data and may be well-formed, such as in a sentence: "That dog is black"; they are also meaningful in some system—namely, the English language. These facts about the data let us confidently say that they afford some information that some dog in question is black.

Information need not be propositional or even linguistic, however; the state of a light may be regarded as data, and it may afford information about the state of your laptop battery. The light's blinking is meant to be meaningful to the laptop owner, and in the system of communication designed by the laptop's engineers, blinking does not break any syntactical rules, whereas intermittent blinking might. Semantic conceptions further distinguish between factual information, such as "That dog is black" and instructional information, such as the contents of a manual that instructs you how to build a bookcase. The SDI is nearly identical to the GDI, except for a fourth criterion. The SDI defines $x$ as information if and only if (from Floridi [2011b] and examined in depth in Floridi [2005])

SDI.1: $x$ consists of one or more data;
SDI.2: the data are well-formed;
SDI.3: the data are meaningful; and
SDI.4: $x$ is true.

The additional criterion requires that information be true to qualify as information. We will return to this definition later.

In either form (GDI or SDI), the semantic conception of information may seem somewhat familiar to followers of the definition debate in IS. First, it shares some features with notions of information as propositions, given by Derr (1985) and Fox (1983), that have been previously examined (Bates, 2005). It goes further, however, to include nonpropositional information and so avoids critiques like those by Kornai (2008) that there is more to a definition of information than propositions only. Floridi's conception also matches an intuitive and broad definition given by Bateson (1972), which is popular in IS: "information is a difference which makes a difference" (p. 448). In terms of a view of information as meaningful data, the first difference ("a difference that . . .") is at least one datum, and the second (". . . makes a difference") refers to its meaningfulness in some system. Lastly, it matches very closely a definition given briefly and without explication in a dictionary of computing that intuits information as "data processed and assembled into a meaningful form" (Meadows, Gordon, & Singleton, 1984).

The account has some intuitive strength, but what makes it distinctly worth promoting given the many other definitions? Furner (2004b) has noted that three criteria are relevant to evaluating a definition: coherence, parsimony, and utility. In what follows, the GDI will be assessed along these three dimensions in relation to other theories of the field. To start, it is worthwhile noting that Floridi's semantic conception of information includes a coherent definition of data. This benefit should not be underestimated. Furner notes that a good theory should go beyond simply defining an item, but to explain the component process of how it qualifies for that definition (p. 444). By giving a concrete analysis of data and linking it coherently to information, Floridi's conception does provide this extra layer of explanation; in doing so, it contributes an understanding of an additional and important piece of the data–information–knowledge construct.

We mentioned earlier that little analytical work has been done to examine the usefulness, rigor, and soundness of previous definitions. Next, we illustrate the usefulness of the GDI for IS contexts by showing how it aids in the understanding of "what went wrong" in counter-intuitive implications of ubiquitous definitions in IS, leaving us with a clearer understanding of what we can actually regard as *information* in each case. Much of what will be said also applies to the SDI, as GDI and SDI share most of their criteria, but we will withhold discussing the unique details of the SDI until the general approach has been shown to be useful.

## Information as Thing, Knowledge, and Process

In "Information as Thing," Buckland (1991) differentiates three ways in which information is explicitly and implicitly defined within IS practice and theory. Although Buckland was aware that the overall account was likely to disappoint the pickiest of theorists, the definitions he detailed nonetheless represent the most common approaches taken by previous definitions. This makes Buckland's account a useful starting point for critical examination, as our examinations of these three senses apply to many definitions that fit within the three categories.

The first sense considers information to be *information-as-process*: the act of informing. Definitions that regard information itself as a process (for example, the act of informing or becoming informed) quickly encounter a challenge: that something we intuitively consider information, like how one might go about utilizing the large quantities of data present on the internet, would cease to be information at all if the related processes (for example, of seeking it) ended. In other words, if the seeker abandons the search for some information, the process is over, and the information is presumably therefore gone. It is counterintuitive to think that we can have direct effect on the existence of information by simply starting or stopping some process related to it, such as that of seeking it. The GDI

avoids this issue, as it can be explicated with "genetic neutrality" (Floridi, 2013)—namely, the idea that data may be meaningful independent of any informee, and therefore information about a topic not as yet researched can still be considered information.

The second sense of information considers information to be *information-as-knowledge*. Definitions that equate information with knowledge encounter various problems because it is unclear how they can account for examples of information that do not seem to be knowledge. For example, instructions for configuring a search engine seem to be information, but the instruction "import the data set via a series of XML statements" does not clearly qualify as a justified, true belief. One might note that justified, true belief is just one definition of knowledge, and although it is the most commonly used, it is not free of problems. This is true enough, but various other definitions of knowledge vary only with regards to knowledge being true or justified; all agree that there must be a belief for there to be knowledge. In the case of instructions, "import the data set" is not a belief or even a believable claim; it makes little sense to say that one believes that "import the data set."

Less narrow approaches to information-as-knowledge might avoid this issue by defining information less strictly, equating it not with knowledge but instead with *that which is known*. In this case, information need not technically qualify as knowledge, but may still be known in some less specific way, such as "that which is perceived in information-as-process" (Buckland, 1991, p. 351). This too entails some worrisome complications, for there are examples that intuitively qualify as information though are not known. For example, we may say that a librarian seeks some information, such as which item would best complete a collection. Since this information is not known, even if simply "not yet known," this special version of the second sense would prevent us from regarding it as information.

Further refinements to sense 2 may be made in an attempt to avoid these problems but lead to further problems of their own. One might suggest that not-known information is still information-as-knowledge, but it is *information-as-future-knowledge*. This too is problematic: in the event that no one is successful in obtaining the future knowledge, it would then not be information. This, in turn, implies that either the information has ceased to exist, which we warned about in our analysis of sense 1, or worse, that those who were unsuccessful in obtaining it were never seeking it to begin with. What, then, were they seeking? It seems wrong to state that they were never seeking anything.

The potential quibbles about information-as-knowledge illustrate the risks of that view: it requires a sound definition of knowledge, but the disputes of philosophy suggest that one does not exist. The more oddities within the chosen definition of knowledge, the greater the risk it will produce unusual conclusions regarding information, future or otherwise.

Lastly, equating information with knowledge risks losing the nuances be-tween domains like information management and knowledge manage-ment that have unique focuses. In sum, these considerations seem to im-ply that information-as-knowledge is not an attractive view.

The GDI allows for *x* to be information regardless of its current or fu-ture status of being or not being knowledge. Sense 2 is not without value, however, as we certainly may want to discuss some information content that is, incidentally, also knowledge content. Preferably so, rather than regarding this information *as* knowledge or vice versa, which serves as a misleading shorthand for referring to some content *x*, where *x* is both information and knowledge.

Buckland defines the third sense, *information-as-thing*, as what we com-monly call computer data, textual documents, and informative physical objects, such as fossils. This sense, he says, is the sense of information most relevant to IS research and practice. Sense 3 represents formal and implicit definitions that identify physical objects as information. That a physical object or thing itself could be information (which is otherwise considered abstract) seems to us an unusual claim: sense 3 seems obvi-ously to only identify examples where information is present, rather than the information itself. Nonetheless, it represents a common implicit and explicit (Jones, 2010) view that an object is indeed information, and so deserves treatment.

First, that information-as-thing is the most important or frequent con-cern of IS practices may be inaccurate, and thus it may not be the best candidate for a characterization of information. Although the physicality or physical representation of some information is a frequent and impor-tant focus of IS, in many cases, the value of the physical representation is first and foremost its content, and not the physical embodiment of it. Consider an end-user, such as a tech-savvy library patron, searching for information about World War II. In many cases, it is likely not of much interest to the patron if they are given a hardcopy of a textbook or an eBook; interest in the embodiment of some information itself is spurned only when we are first interested in the content; this alone does not make information-as-thing an untenable view, however.

Second, to regard physical objects as information is intuitive, but not clear; it is intuitive because we often speak about physical objects as though they *are* information, particularly in cases of digital media or when scientific knowledge may be gained from some interesting natural phenomenon. For example, we may say that a DVD-ROM disc is infor-mation or that a stem of the quaking aspen is information. It is unclear, however, once one moves beyond a face-value interpretation—what in-formation could an object itself be? For example, what information *is* a DVD-ROM? One may think that the information is that which is or could be contained, held, represented, or transmitted by the DVD. These are

reasonable thoughts, but that which is contained by an object is not the object itself; water is not the bottle that contains it. One may think of the information "the DVD has a certain weight, a certain color, and certain properties like flexibility, reflection," and so on, but those are traits *of* the DVD and not information that the DVD itself *is,* and this is the claim of information-as-thing. If, after all, information-as-thing is meant to provide a definition of information rather than merely providing examples of places where information exists, then it must state that *the thing is the information.*

Lastly, a more technical issue in identifying things as information is found in the implications of the view: if *things* are information, two identical things should afford identical information, but they may actually yield different information in different contexts, such as different times or places. For example, a copy of *The Adventures of Sherlock Holmes* that is set on a table in Paris may yield different information than an identical copy set on a desk in Berlin: while the former affords the information that it is in France, the other does not. Further, this seems true of *one* object placed into two different times or places: it will yield different information within the different contexts but cannot be identical to two bits of information that are nonidentical to each other. Objections may be made by means of metaphysical views that identities do not persist across time or similarly across space, but these objections illustrate the difficulty in equating information with things: theories of identity (of things or otherwise) are contentious, and so it is better to give a definition of information in terms of consisting of data than to equate information with things themselves.

The GDI, in contrast, allows that information may be represented, such as by electrons on a hard drive that represent information in a file, or by a blinking light, or by one of many other modes of representation and communication, without allowing that the drive itself or light itself is an instance of information. Buckland (1991) said of Meadows and colleagues' definition of information, which matches closely the GDI, that it "leaves unanswered the question of what to call . . . informative things" (p. 356). Given this common use of the word, it may seem counterintuitive to say that a fossil is not identical to information and *is not even an instance* of information. What we have shown here is that "informative things" is less problematic than three popular alternatives, and we can instead call documents and fossils *carriers* of information. A DVD-ROM is not information, but it carries information and is itself a meaningful datum that may combine with other meaningful data in a well-formed manner, thus affording information.

Through this explication, we see that although information-as-process, -knowledge, and -thing as they have been previously defined make for problematic definitions of information, alone, none of these views are sufficient accounts of information. Taken together, they form a more

comprehensive account but one that is a characterization of some of the *instances of* information that may be found rather than a definition or analysis of what these instances have in common.

## Information as a Pattern of Energy or Matter

Buckland's summary and categorization of previous definitions has since been made incomplete, as new kinds of definitions have recently been given. In two companion papers, Bates (2005, 2006) has been motivated by similar concerns about the usefulness of many definitions, and thus emphasizes the utility to be found in developing an existing, but not fully explicated, definition given by Parker (1974). This usefulness, she contends, is due to the definition being grounded in an evolutionary biology framework that concerns how and why animals perceive and process information.[4] Bates relates Information 1, described by Parker and others, as "the pattern of organization of matter and energy" (Parker, 1974, p. 10), and then refines this into Information 2: "some pattern of organization of matter and energy that has been given meaning by a living being" (Bates, 2006, p. 1042). Bates is aware that a good definition should help us to understand the other components of the data–information–knowledge hierarchy, and so defines knowledge as "information given meaning and integrated with other contents of understanding" (p. 1042). She (2005) thus also defines data: Data 1 are regarded "as that portion of the entire information environment available to a sensing organism that is taken in, or processed, by that organism," while Data 2 are regarded as "information selected or generated by human beings for social purposes" (n.p.).

Bates's overall conception of information can be seen as a variation of the information-as-thing category but deserves further consideration; it is one of the most widely used definitions in IS, seems to account for many forms of information used in other fields, and both specific definitions of information (1 and 2) can be seen as having a few noteworthy advantages. First, by allowing that some pattern of organization of energy or matter is an instance of information, there is similarity of the scope of her definitions to the widespread intuition about the ubiquity of information in the world: because we feel that there can be information about everything, it seems appropriate that we should be able to define information so broadly. Second, the exclusion of something from the definitions (total entropy) seems a good sign, as definitions aim to demarcate that which is being defined from that which is not. Third, Bates's view allows for definitions of data and knowledge, which she then relates to information.[5] Lastly, the "fundamental forms" that Bates outlines are useful characterizations of instances of information, and they likely remain useful regardless of which definition of information one adopts. These advantages make a strong case for Bates's definition being one of the richest and most fruitful efforts toward defining information that has come from within IS. As we will

see, her view comes very close in its character to the GDI (and thus also the SDI), but in its differences, Bates's view holds a few theoretical and practical problems.

The breadth of this account, which contributes to an intuitive strength, also contributes to a problematic implication by conflating data with information. This conflation is similar to the one made by Buckland and other varieties of the information-as-thing definition, but not *exactly* similar: whereas Buckland conflated physical objects with the information they afford, Bates's conflation is broader, including also patterns, such as words, designs, and concepts. Her account makes the same mistake that is made in much ordinary use of the word *information*; this implies that the mistake of conflating information with some informational phenomenon is easy to make. Therefore, we provide two further examples.

First, assume, as Bates's view implies, that the words *file*, *fichier*, and *Datei* themselves are information. From their differences, it should follow that they carry different information. But these words have identical meaning: they carry the same information that enables us to think about some objects in the world as computer files. In other words, different patterns may afford the same information, and therefore cannot be that information. Second, it follows from Bates's view that smoke itself is the pattern of organization of some matter, and hence that smoke *is* information. Yet, what informational content is some smoke identical to? At the outset, the obvious information that may be gleaned is that there is a fire, that this particular smoke has some color, and so on. But none of these conclusions are smoke itself; rather, they are information yielded by the smoke and thus not identical to it.

By instead viewing information as meaningful and well-formed data, we can regard smoke itself as a datum that affords certain information, such as those described above, the word *smoke* as meaningful data that refers to the physical smoke, and the words "*Datei* is German for file" as a sentence that carries information. The information is composed of data, "such as German" and so on, and these data are meaningful and well-formed in the context of a linguistic system.

We said that the breadth of Bates's account is what produces a problematic implication. The implication is that patterns are themselves information, despite there being no obvious informational content present and despite differences in the patterns. What a semantic conception of information, like the GDI, allows us to see is that Bates's definition is too broad insofar as it includes data, called "patterns" by Bates, and thus conflates the components of information with the information that they yield.

Bates seems aware of critiques stating that she conflates information with data, or something like it: "Some readers of this essay in manuscript have argued that this definition of information simply equates *information*

with *pattern* and that the definition is therefore trivial. I do not follow the logic: even if I were doing that, if I could make a good case for that definition and its usefulness to the field, would that not be a step forward?" (2005, n.p.; emphasis in original). That Bates's view contributes to a step forward and advances an understanding of information is a claim with which we happily agree, and as we have acknowledged above, we do not find her definition trivial. The conclusion, however, that one ought to maintain such a definition in light of counterintuitive implications and good competing theories seems to us untenable.

Through a different analysis, Hjørland (2011) arrives at perhaps the same problem with Bates's definition: "I see no need, however, to term such differences 'information.' This is in my opinion not necessary and it is confusing. Differences are thus not information until they inform somebody about something" (p. 547). The GDI allows for agreement with Hjørland's view that differences themselves, called diaphora or data, are not information. Where the views differ is on Hjørland's concluding sentence; if written with the GDI in mind, it would read: "Differences are thus not information until they are meaningful and related in a well-formed manner."

Given that previous strong definitions of information have theoretical weaknesses and counterintuitive implications for practical uses and given that we are able to understand these flaws by conceiving of information as well-formed and meaningful data, Floridi's account seems increasingly attractive for use in IS. To make the account's usefulness even clearer, we describe a few examples of how it might facilitate understanding the *information* aspect of common IS events and items: a nonfiction book is not itself information but contains representations of information about the world; a valid RDF triplet is not information but is a digital abstraction that represents some information by describing three datum as subject, object, and predicate; a postings list is a data structure containing representations of data as words in the keys column and affords information about those data via the data in the values column—for example, that the word *cats* occurs in a document collection "forty-five" times; a recipe is a representation of instructional information, likely printed on paper or stored on a computer; an MP3 file is a certain series of bit values that represent audio data in a certain order that people may want to hear; an antelope is a physical object that carries certain data, and these may afford us certain information—for example, that the antelope is healthy; that which a web-search user is seeking is information that is represented by text on a page, or perhaps by depictions in a photo; and last, an organizational shared hard drive is a storage place for files fashioned into documents, which contain representations of information pertinent to operations.

The characterizations in this incomplete list are useful in understanding and discussing the materials and processes of IS practitioners; these

illustrate the practical strength of the GDI. It is a theoretical strength that the GDI aids in making sense of previous definitions and in doing so helps to clarify the theoretical picture produced by all of the previous definitions. To demonstrate practical implications, we return to our example of the case study of the reference librarian. If defining information-as-process as Buckland and others do, the book that the patron is already knowledgeable about would not be considered information. This is counterintuitive and confounded. If defining information as a pattern of matter or energy as Bates does, the blank note-taking paper itself would count. This is counterintuitive and problematic. If information is defined as well-formed, meaningful data, however, the blank paper would not count, but the poetry and redundant book would. The internet URL would be considered a datum, itself part of the information that what the patron seeks lies at the destination page.

Karamuftuoglu (2009) has argued that IS should concern itself with particular definitions of information, focusing on epistemological, aesthetic, and ethical angles, and borrow heavily from philosophical methods in doing so. Here, we have identified one such definition, used in the PI, that is theoretically sound and useful in describing common IS concerns.

## GDI, SDI, and the Role of Truth in Information

Now that we have illustrated the usefulness of a view of information as well-formed, meaningful data for understanding both common IS-related contexts and the theoretical framework resulting from many previous definitions, we must address our reasoning for preferring the GDI over the strongly semantic definition of information (SDI). To recap, the SDI is identical to the GDI but has an additional, fourth criterion: for $x$ to be information, $x$ must be true. The relationship between truth and information (and librarianship) is an established topic of interest in both philosophy and IS (Floridi, 2004c; Labaree & Scimeca, 2008). Floridi (2004a) himself prefers the SDI for philosophical uses; for IS, however, he only takes us as far as a general semantic concept of information, noting that librarianship specifically deals not with knowledge but with "contents understood as meaningful data . . . connected with the activity of stewardship of a semantic environment" (p. 662).

The claim that $x$ must be true to be information has been made independently of the SDI, under the name "the veridicality thesis." Motivations for maintaining this thesis range from intuitive, such as that a transparent lie does not seem informative and false information is not information any more than a rubber duck is a duck (Dretske, 1981), to a technical paradox resulting from allowing information to be false (Floridi, 2004b, 2004c).[6] Floridi's conclusion from this paradox, that information must be true, manifests in SDI.4 and has been further formalized by Cevolani

(2011). As far as we can discern, it is often unclear in explications of the SDI whether or not this requirement extends beyond factual information: instructional information is explicitly absolved of the requirement, but categories like poetry and fiction are often not discussed.

Perhaps unsurprisingly, the veridicality thesis is contentious within philosophy. Against it, Fetzer (2004a) demonstrates various linguistic instances where requiring truth obscures the differences among information, misinformation, and nontruth-evaluable sentences. Similarly, Scarantino and Piccinini (2010) point out more nontruth-evaluable claims as well as list examples from computer science that are false, yet informative. In an attempt to avoid the need for the veridicality thesis, Primiero (2009) formalizes a logical approach to describing information that does not rely upon a notion of truth and thus does not arrive at such paradoxes. In retort to arguments like these, Floridi (2005) has provided reasons why various resistances to the veridicality thesis are flawed.

Like many topics in philosophy, the debate surrounding the veridicality thesis remains unsettled. Even the distinction among information, misinformation, and disinformation are debated (for example, Fallis & Carlin, 2011; Fetzer, 2004b). Fortunately, commitment to a definition need not be made on theoretical grounds alone; in light of disagreement about the veridicality thesis, it may be argued that whichever position is more practically useful should be adopted.

The practical motivations for IS to either adopt or ignore the veridicality thesis are a relatively untouched topic. Might there be practical concerns for IS that would favor an opposite view, to allow that $x$ need not be true to be considered information? We think so. First, there may be content in frequent IS practice that we regard to be information that is false, disputed, or not truth-evaluable. Consider categories like fiction, instructions, recipes, poetry, conversation logs in e-mails and on paper, and abandoned notions like old laws of nature once held in high regard by the scientific community. Poetry may be nontruth-evaluable, the claims in astrology books are disputed, and it is unclear if reports about fictional characters are true, false, or neither. Some of these categories get a "free pass" by some implementations of the veridicality thesis (for example, Floridi's view of instructional information and recipes), but other categories are not addressed, and some others, like fiction, do not pass as information. All of them, however, are of interest to information professionals and researchers, as well as to our patrons, students, users, and clients, perhaps as much as factual information, and so their exclusion from the definition of information seems unwanted.

If the debate about the veridicality thesis remains unsettled, it seems more useful to regard the contents of these categories as information. The extra restriction that the veridicality thesis adds to the SDI over and above the GDI serves only purely theoretical motivations, such as to avoid

paradoxes that manifest in the technical writings of philosophers. By contrast, allowing poetry to qualify as information would incur neither a paradox for nor obstacle to reading it but would instead allow it to be usefully categorized, sorted, archived, filed, retrieved, borrowed, and consumed alongside other information, regardless of its alethic value. That there seem to be so many cases of fictitious, disputed, and nontruth-evaluable information in IS may actually be a reason against an even purely theoretical acceptance of the SDI: it is highly counterintuitive.

What if the veridicality thesis is true? In discussing philosophers' resistance to the thesis, Floridi (2010b) acknowledges that utility often requires a tempering of pedantry in applied contexts:

> It would be daft, for example, to identify a piece of software as information—as we ordinarily do in IT and computer science—and then argue that, since information must be true, so must be that piece of software. "True about what?" would be the right skeptical question. Likewise, it would be unduly pedantic to insist that, given the veridicality thesis, cognitive scientists should stop speaking about information processes. (p. 406)

The same applies to IS contexts in which information is either not obviously true or truth-evaluable.

Lastly, Budd (2011) and Lingard (2013) have emphasized the importance for a good theory of information to address the relationship between truth and information. Lingard, however, disagrees with Budd that information requires truth, arguing instead that information has ontological primacy, and truth and meaning are thus properties of information rather than being necessary for its existence. We agree and think that a useful way that the GDI could therefore be expanded to address the relationship between information and truth, while still giving ontological primacy to information and thus avoiding the veridicality thesis, would be to regard truth as a sufficient condition for information rather than a necessary one: if $x$ can be regarded as true, then it must meet all of the criteria of the GDI and so $x$ can be regarded as information. This complements Fox's (1983) view that information does not require truth, but misinformation requires falsity. In this way, truth serves as a shortcut to identifying information rather than an obstacle. Our position that the GDI is preferable to the SDI for use in IS also complements the work of Labaree and Scimeca (2008) in which they argue that "library practice requires a suspension of truth" (p. 67) to be fully purposeful, extending the sentiment to conclude that truth, although important, needs to be usefully limited for our domain.

## CONCLUSION

We have endeavored to show that the GDI is a suitable working definition of information for use in IS. To do this, we addressed concerns about the

prospect and necessity of finding such a definition; although a unified theory of information may be impossible, a discipline-dependent definition is desirable and may suffice for internal uses. This is more desirable, we think, than avoiding the use of the term *information* and choosing a position of ignorance about the main phenomenon of our field. We have also made some sense of the "many definitions problem" by analyzing the shortcomings of two accounts that have received much attention, one of which is, in turn, a categorization of previous definitions. In utilizing the GDI for this task, we have demonstrated the theoretical strengths of Floridi's view of information as meaningful, well-formed semantic data. In short, Buckland's (1991) view of information-as-thing conflates information with the object that yields it; information-as-process and information-as-knowledge conflate information with particular processes and knowledge in which information is featured; and Bates's view of information as patterns of energy conflates information with data. We have provided concrete examples of how the GDI describes and helps us to understand the common practice and research concerns of IS. Lastly, we have demonstrated reasons for favoring the GDI over the SDI, in light of the needs of IS practitioners and researchers. Floridi (2010b) has noted that philosophers do not complain about grocery stores putting tomatoes and courgette in the vegetables section, despite the fact that they are actually fruit. Similarly, if the veridicality thesis is true, it may not matter much to IS because we have found a framework useful for going about our business.

Like Floridi's account of the grocer, we would never chide someone for asking "have you attached the information?" even if by the definitions promoted here the attachment is really a file that contains representations of data. Instead, we are here promoting the view that information scientists and professionals be able to quite precisely and confidently define *information*, and in turn *data*, and use the words both technically and informally but with acuity and knowledge of the differences: namely, that data are the values of any identifiable differences; information is well-formed, meaningful data; and for the purposes of our field, information need not be true. The examples we have provided are primarily concerned with identifying and understanding what information *is*; when a definition is needed to identify information in research or practice, we recommend the GDI. There are instances in IS, however, such as studies in information retrieval, that may need to quantify information as well. Fortunately, the GDI can be complementary to quantitative approaches to understanding information; for example, Chen and Floridi (2013) have used both Floridi's GDI and Shannon and Weaver's MTC to analyze visual information, using the former to identify and the latter to quantify information.

The result of this analysis, we hope, is that the search for a definition of information has been advanced and need not be suspended. It is ad-

vanced insofar as we have defended an existing definition rather than posited an additional definition without critically examining its implication for previous definitions. If the search were to be suspended, it would not be because we have found a perfect definition nor have given up looking for an acceptable one, but because we have found one that is coherent and useful for both applied and theoretical purposes. Zins (2007) has suggested that the field must adapt its understanding of fundamental concepts to match their evolving applications. Our perspective is that it will take another information revolution to make the GDI obsolete.

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## NOTES

1. These and other applied theories of information do not define the essence of information but rather quantify information or characterize *how it works*. Nevertheless, they are often still philosophical, interesting, and very helpful for understanding the various aspects of information. See Cohen and Meskin (2006) for one such example of philosophical writings about information theory, which usefully detail how information "works" in several contexts. What they do not do, however, is state the necessary and sufficient conditions for identifying information.

2. Adriaans (2010) describes Floridi's account of information as "orthogonal" to quantitative accounts found in physics and computer science and concludes that it is actually contradictory to such accounts (p. 41). Despite this view, Chen and Floridi (2013) have used both Shannon and Weaver's MTC and Floridi's GDI to analyze visual information, demonstrating that quantitative and qualitative accounts can be complementary.

3. Although widely accepted at face value, this reading of Bateson is contested by Sloman (2011).

4. Bates states that her view implies that information is emergent—that is, novel and irreducible to its component parts. That information is emergent actually seems contrary to her definitions, however, because all of them are constructed solely in terms of their parts, and none are demonstrated to be irreducible to those parts.

5. The degree of usefulness of Bates's definition of knowledge is necessarily limited to the few paragraphs of explanation to which she has confined it. Given the rich history of understanding and defining knowledge that has been contributed by philosophers, it is unclear why it is desirable to formulate one ex nihilo rather than to draw on a definition that has the benefit of centuries of refinement.

6. This problem is dubbed the "Bar-Hillel–Carnap paradox": if information content can be gleaned from the set of possible worlds excluded by its truth, then logical contradictions have maximal information content because they exclude all possible worlds. This is explained further in Floridi (2004c).

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