Information-not-thing: further problems with and alternatives to the belief that information is physical

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Abstract: In this short paper, we show that a popular view in information science, information-as-thing, fails to account for a common example of information that seems physical. We then demonstrate how the distinction between *types* and *tokens*, recently used to analyse *Shannon* information, can account for this same example by viewing information as abstract, and discuss existing definitions of information that are consistent with this approach.

Résumé: Dans ce court article nous montrons qu'une vision populaire en sciences de l'information, l'information en tant qu'une chose, échoue à rendre compte d'un exemple commun d'information qui semble physique. Nous démontrons ensuite comment la distinction type/token, utilisée récemment pour analyser l'information de Shannon, peut rendre compte de ce même exemple en considérant l'information comme abstraite, et nous discutons des définitions existantes de l'information qui sont compatibles avec cette approche.

Introduction

Understanding the nature of *information* and agreeing on its definition has proven extremely difficult for scholars in many disciplines. Scholars of information have articulated many views and definitions, divisible into several categories (Bates, 2009), while philosophers have worked to refine rigorous semantic definitions, and scientists have joined them to better understand mathematical definitions. Among this plurality of definitions is a view of information as a physical object, or information-as-thing (Buckland, 1991), which remains popular in the information sciences (IS; including information research and education, libraries, archives, museums, and information and cultural preservation institutions).

In Dinneen and Brauner (2015) we argued that all three senses of information discussed in Buckland (1991), information-as-thing, -as-knowledge, and -as-process, which represent many previously given definitions of information, are practically and theoretically inadequate for use in IS. Here we pursue this thesis further by noting another problem entailed by viewing information as physical, and showing how using the type/token distinction avoids this problem while better accounting for examples of information.

Information-as-thing

The intuitive notion that information is physical, most famously explicated as information-as-thing (Buckland, 1991), is fervently defended in IS. Despite qualifying that information-as-thing is a representation of knowledge that cannot be confused with the knowledge itself, Buckland also argues at length that information systems deal *directly* with physical information, including bits, books, and objects (p.352). In Dinneen and Brauner (2015) we noted two problems with this view: (1) that identical objects can afford non-identical information, and *vice versa* that (2) non-identical objects can afford identical information. These problems suggest that physical things cannot be information, and information therefore cannot be a physical thing; here we examine an additional, related problem.

Take as an example a library patron borrowing, reading, and returning a book about how to perform gardening tasks. In the view of information-as-thing, the book's author creates physical information about gardening, either *as* the book itself or *within* it, and the patron then views (reads) the information-as-thing (book), and by this process, in successful cases, obtains information.

At face value, this account is intuitive, but it is problematic if taken seriously as a claim about the nature of information. For, simply, if the information gained by the patron was the same entity that *is* the book (or its printed contents), they would lose the information upon returning the book. This sounds absurd, of course, and we intend it to, because the selfsame information that *is* that particular book obviously cannot simultaneously be in two distinct places (e.g., on the shelves and possessed by the patron). The obvious response is that the patron has produced their own copy of the information (e.g., information-as-knowledge), but this implicitly abandons the idea that the physical object *itself* is information in any meaningful sense: the patron possesses not a book or its printed words (nor a copy or representation of these), but rather possesses the information *how to garden*.

Though our example here was of a book, this problem and the ones of identity discussed in Dinneen and Brauner (2015) apply to objects in museums and archives, and bits on drives, and may also apply to views of information-as-process, depending on whether the processes are physical in their nature. Next, we look at an alternative account of the example.

Information as type

Another way of understanding our example can be found in applying the analysis made by Christopher Timpson in his well-known PhD thesis on quantum information, later refined and published in a book (Timpson, 2013). We explain his view first, then adapt it to our example.

Starting with classical approaches to information, Timpson analyses Shannon's mathematical formulation of information, and identifies a distinction in Shannon's work[i] between information as quantity, or the amount of information produced or transmitted, and information as piece, or that which is produced or transmitted (Timpson, 2013). Timpson argues that both kinds of information are abstract. For information quantity, this is straightforward: quantities are abstract.

Understanding why information as piece is abstract requires first understanding a simple distinction, popularized by C. S. Peirce and widely used in philosophy and science (Wetzel, 2006), between types and tokens.

Timpson states that the aim of communication protocols is to reproduce at a destination a token of some message type (Timpson, 2013). For example, two sequence tokens {1, 3, 5} and {1, 3, 5} are of the same type and so when compressing and transmitting these sequences "the piece of information is not the token produced at the source [or reproduced at the destination], but the corresponding type" (Lombardi, Fortin, & López, 2016). In other words, the sequence {1, 3, 5} should be produced at the destination, but it need not be the same token of that sequence found at the source. So information as piece is abstract, because it is a type, and types are abstract. Details of Timpson's argument have been critiqued and refined (Lombardi, Fortin, & López, 2016), and his view of mathematical information as abstract is now generally accepted among philosophers of physics (Lombardi, Holik, & Vanni, 2016).

We return now to our example of the patron borrowing a book on gardening. Using the type/token distinction, we may say that an author possessed information tokens of types describing how to do various gardening tasks, created separate tokens of those types while penning the book, that many additional tokens were made when the book was printed, and that when a patron reads the book, assuming they did not already know how to garden, they form their own tokens of the intended types. The author is concerned while writing the book that with their words they have accurately represented the information they wish to convey, that is, the information types. The book's copy editors and typesetters are concerned that the tokens look a certain way, but are typically uninterested in the particular information types implemented. A patron is concerned with reading the book in such a way that they understand what the author was trying to communicate, that is, that they form tokens of the correct information types. We may say that exposure to the book's information token (by reading) has produced in the patron's knowledge tokens of the same information types as the author's tokens.

Timpson saw that his argument may apply to everyday senses of information in addition to mathematical ones, and it seems here that it is useful for accounting for an everyday case of information. The resulting account is more sensible than the one produced by viewing information as physical, wherein information seemed to be breaking an object's identity by allowing it to be in two places at once, and does not encounter the problems we identified in our previous work. Buckland, who coined information-as-thing, was aware of the type/token distinction, and even employs it in the same paper where information-as-thing is outlined to discuss the relative value of copies (tokens) of texts and digital records (types). For example, Hesse's novel *Steppenwolf* is a type, instantiated in many tokens (printed copies). But we have demonstrated here that the distinction applies further still, to information itself: information systems (libraries, computers) deal with physical objects (books, hard drives) that contain or encode tokens (text, bits), which represent some information type (facts or fiction, applications, records). The preservation, management, access, study, and so on of both information types and

tokens is of interest to us in IS, but information tokens are of concern and value not in virtue of *being* information, but in virtue of being tokens that implement information types. This enables producing, for example in a reader's knowledge or remote server's hard drive, other tokens of the same type, and because they do this, we take interest in them. This is consistent with Popper's view of three worlds, influential to many foundational writings in IS and summarized nicely by Bates (2009): information objects (tokens) are part of *World 1*, the physical world, and their logical contents (information types) are part of *World 3*, an abstract world.

Conclusion

Information professionals, researchers, and educators should be sensitive to common conceptions of information, but benefit nonetheless from having a rigorous understanding of the nature of information. Views of information as physical, such as information-as-thing, encounter problems in accounting for typical cases of information, and viewing information as an abstract type avoids these problems and provides a better account. That information is abstract is consistent with some existing definitions of information, including Marcia Bates's (2006) definition of information as "the pattern of organization of energy or matter", Luciano Floridi's semantic conception of information as true, well-formed, meaningful data (Floridi, 2005). Bates's view explicitly distinguishes information (a pattern of organization) from its physical matter or energy, and patterns may be conceived of as abstract and as types. Floridi's view requires that data be represented, but does not require "material implementation of the data representations" (Floridi, 2015, 1.6), and so the data may be abstract, producing abstract information. Both views therefore avoid the problems of physical information discussed above.

We have previously discussed the strengths and weaknesses of both views (Dinneen & Brauner, 2015), stating that Bates's constitutes an excellent contribution to understanding the character of information and deserves refinement to avoid conflating data with information, and that Floridi's view is theoretically and practically robust for use in IS, but excludes some intuitive examples of information, such as fiction and poetry, because they are not *true* in the traditional sense. However, Floridi *does* articulate how these items can be regarded as true[ii] at some level of abstraction (Floridi, 2011). Further analysis is required to understand the full implications of this for implementations of Floridi's definition in the information professions, but the theory's ability to account for such categories should be noted and regarded as a theoretical strength.

While the definition of information adopted in any given instance of information research, practice, or policymaking will likely answer foremost to practical concerns, we have shown above how theoretical confusions present in some definitions may entail unwanted practical manifestations, and thus encourage the use of sound definitions such as those viewing information as abstract.

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[i] Lombardi, Fortin, and López (2016) contest that this distinction is explicit in Shannon and Weaver (1949), but once possessed the distinction's origin is not essential to the present discussion.

[ii] We thank Prof. Betsy Martens for bringing this to our attention.

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