Chapter 7
Information Without Information Studies

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7.1 Introduction

Several options suggest themselves as approaches to answering questions like "What is information?"

- We could do some *empirical science*. We could find some information, observe it, determine what it's made out of, how it comes into existence and what effects it has, measure its quantifiable properties and its distribution across space–time, and report on our findings.
- We could do some *history*, maybe mixed with a little *sociology*. We could study the development, over time and across cultures and disciplines, of the use of the term "information," and explain how different conceptions reached different levels of prominence in different contexts.
- We could do some *conceptual analysis*. We could identify the conditions that must be met if we are to accept any given candidate as an instance of the category that we label "information" in ordinary language (or in whatever technical language our community uses). In other words, we could clarify the meaning that the term "information" has for us.
- We could do some *ontology*—"proper" ontology, in the terminology of Jonathan Lowe (2011). We could start by asking, not what information *is*, but what information *could* be. Proper ontology in this sense is not a matter of analyzing concepts, but a matter of "envisag[ing], in a very general way, what sorts of things there *could be* in the world, at its most fundamental level of organization or structure, and then ... develop[ing] arguments for or against the existence of things of this or that general sort" (Lowe 2011: 104).

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F. Ibekwe-SanJuan and T.M. Dousa (eds.), *Theories of Information, Communication and Knowledge*, Studies in History and Philosophy of Science 34,
DOI 10.1007/978-94-007-6973-1_7,

If we turn to the literature (without limiting ourselves to any particular discipline), we find that the post-1950 discourse on the nature of information is replete with examples of at least the first three of these approaches. We also find that individual contributions have had purposes of several distinct kinds:

A. to present, and/or to advocate for, a *single* conception of information that was first formulated elsewhere;
B. to review, and/or to classify, a *range* of existing conceptions of information; and
C. to present, and/or to advocate for, a *new* conception of information.

These three categories of purpose suggest a second way of classifying individual contributions. Each of these categories may be further subdivided into those contributions that present at least one *general*, discipline-independent conception capable of universal application, and those that present at least one *special*, discipline-dependent conception intended for application in a context with specifiable boundaries. Contributions in category B—i.e., reviews—may be evaluated against criteria that include exhaustiveness (over conceptions, and across disciplines), validity (of the authors' choice of the dimensions on which conceptions are classified), and utility (of the results of the review).

A third way to classify contributions would be to distinguish the *disciplinary* affiliation(s) of their author(s): Some scholars self-identify with fields (such as "information science," "library and information science" [LIS], and "information studies") whose roots lie in earlier explorations of bibliography, librarianship, and documentation; others approach the study of information from the perspectives of scientific and technical disciplines such as computer science, physics, and biology; others still are embedded in various other social sciences and humanities.

With this chapter, it is not my intention to provide a contribution in any of the three categories of purpose (A, B, or C) identified above. Instead, I would like to suggest (by example) a way of conducting a meta-analysis of contributions, with the following goals:

- to introduce a fourth way of classifying contributions to the literature on the nature of information—one that involves identification of authors' ontological commitments;
- to propose a framework for defining the range of ontological possibilities for things that have been called "information";
- to examine the ontological commitments of some of those whose work may be less familiar to an LIS audience; and
- along the way, to clear up some residual confusion about the nature of the relationships among different conceptions of information.

In Sect. 7.2 following this introduction, the way in which we might take an ontological approach to the analysis of information concepts is described in a little more detail. In Sect. 7.3, I begin an investigation of "what information could be," by constructing a preliminary list of candidates, classified by ontological category. In Sect. 7.4, I look to probability theory for some additional candidates that have assumed considerable weight outside LIS, and explore the significance of a basic distinction that may be drawn between conceptions of information-as-informativeness, and conceptions of information-as-informative. In Sect. 7.5, I examine the ontological commitments of three authors writing about information from perspectives outside LIS. In Sect. 7.6, I focus on the work of two representatives of a recently-emerging community of scholars that, while dedicated to establishing "the foundations of information science," has not (yet?) formed strong ties to LIS. Lastly, in Sect. 7.7, I tentatively conclude that any approach to conceptualizing information that downplays the contributions of LIS—i.e., information without information studies—is needlessly impoverished, not least on account of the range of ontological possibilities that it misses.

7.2 An Ontological Approach to the Analysis of Information Concepts

Ontology is the branch of metaphysics that is concerned with identifying and understanding the fundamental categories or kinds of things that exist in the world.[1] For any information-related phenomenon, we may ask, What *kind* of thing is it? A *concrete* thing (existing in space–time as a "datable and locatable" object or event that is capable of undergoing change and/or of causing effects), or an *abstract* thing? A *universal* (that is instantiable or exemplifiable), or a *particular*? A *substance* (that is characterizable), or a *property*? An object or an event? A set or an element? One of the tasks of ontology is to identify, characterize, and relate these different categories in a coherent framework. The main structural features of one such framework—Jonathan Lowe's "four-category ontology" (Lowe 2006), whose antecedents may be traced at least as far back as Aristotle—are depicted in Fig. 7.1.[2] Lowe distinguishes *kinds* (substance-types), *objects* (substance-instances), *attributes* (property-types), and *modes* (property-instances). In this scheme, types are universals, and instances are particulars; and the only entities that are concrete are some objects.

Different thinkers have different views on the existence (i.e., the reality) or otherwise of entities in various categories—in other words, they have different ontological commitments, and may be regarded as realists or anti-realists with respect to the entities in any given category. In the philosophical literature, authors typically make their ontological assumptions well known, especially if those assumptions form the foundations on which are built understandings of the concepts under analysis. In LIS, on the other hand, such views are not frequently made explicit, notwithstanding their equal importance for the development of cohesive and powerful conceptual frameworks. Nevertheless, if we are successfully to specify

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[1] See, e.g., Loux (2002) for an authoritative introduction to this field.

[2] Figure 7.1 is adapted from Figure 1.2, The four-category ontology, in Lowe (2006: 18).

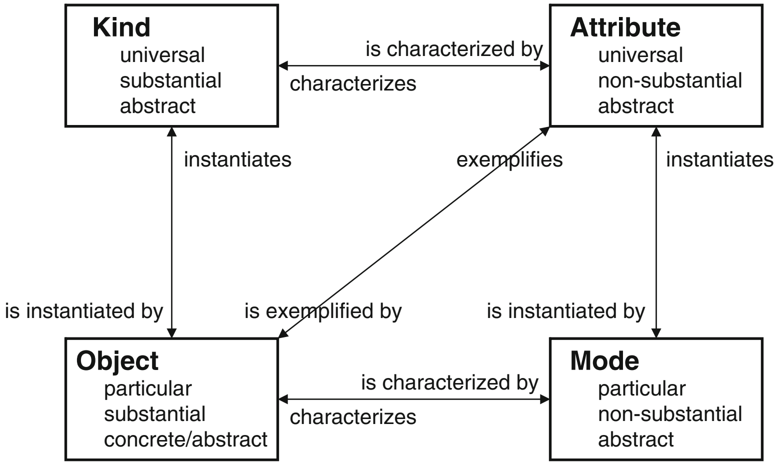

Fig. 7.1 Lowe's four-category ontology

the distinctive nature of various conceptions of information, it is essential that the ontological commitments underlying their authors' theories, arguments, and knowledge-claims be revealed.

Lowe has argued that "proper" ontology involves *a priori* reflection and argument about the *possibility* of sorts of things, as "an indispensable prerequisite for the acquisition of any empirical knowledge of actuality" (Lowe 2011: 100). Were we to proceed with an inquiry into the nature of information along these lines, one specific strategy would be to begin with one of the existing frameworks that purport to catalog the various fundamental sorts of things that there are, to exhaust the various possibilities by which information may be related to each of the existing categories, and to consider whatever additional possibilities there might be for revising the framework in the light of information's distinctiveness. Lowe's (2006) own framework (as partially depicted in Fig. 7.1) gives us the motivation to consider the possibilities of information-as-*kind*, information-as-*object*, information-as-*attribute*, and information-as-*mode*. How far might that project get us? To find out, let's start at the beginning.

7.3 What Information Could Be

You flip a coin. It comes up Heads. You write down "It came up Heads" as a note to yourself; but (for reasons unknown) you tell me "It came up Tails." In this scenario, where, precisely, is there information?

If being true (i.e., correspondent with reality; accurately representative of the facts) is a necessary condition of being information, then whatever it is I get out of this exchange, it isn't information. If being productive of a change in a recipient's state of knowledge is a necessary condition of being information, then (according to most definitions of knowledge, which include truthfulness as a necessary condition thereof) I'm not receiving information in this case, either. Maybe a change in a recipient's state of belief is what we should be looking for? Any exploration of that route will lead us to one of the versions of what has often been called a "subjectivist" concept of information, whereby whether something counts as information or not depends on the nature of the effects it has on the observer. Alternatively, we might decide that we need to pay closer attention to your intentions. Maybe the necessary condition we seek is the motivation of the sender to represent reality, to express themselves, to influence people, to get things done with words, to communicate … Is information the "content"—i.e., the meanings—of speech acts, and that's that?

But to stop there would be to have opened only one or two compartments of an expansive toolbox. Information as what generates changes in human knowledge/belief states; information as what is produced by human acts of representation; information as signal, as sign, as evidence; information as difference; information as everything—the list of distinct conceptions is long, and may be organized in many more-or-less helpful ways, several of which are well-known in LIS. Furner (2010, 174–175), for example, provides a conceptual framework that differentiates between (i) a *semiotic* family in which distinctions are drawn among real-world situations, mental representations of those situations, and linguistic expressions of those representations; (ii) a *socio-cognitive family* in which the emphasis is on action and process, and especially processes by which people become informed or inform others; and (iii) an *epistemic* family in which conceptions are developed with the aim of providing an account of the properties that an information resource must have if the beliefs that are generated upon interpreting the content of that resource are seen to be justified. The origins of these conceptions may be traced to various cognate disciplines, including cognitive psychology, linguistics, philosophy of language, semiotics, computer science, physics, and biology, and it is these communities to which authors typically look when they embark on analyses of the nature of information.

An undoubtedly incomplete list of the phenomena that are involved in the coin-flip scenario, categorized according to Lowe's ontology, is presented in Table 7.1. In order to make progress with our exploration of the range of ontological possibilities, we might consider each of the entries in the list as a candidate for satisfying the conditions for informationhood.

One of the obvious ways in which, as it stands, this list is far from complete is in its omission of a number of categories of property-instances that have great significance within conceptions of information derived from probability theory. Despite their widespread acceptance in applications of Shannon's mathematical theory of communication (Shannon 1948) in the natural sciences and in engineering, these conceptions are typically not as sympathetically addressed in the LIS literature, and a quick review might be helpful.

Table 7.1 Information-related phenomena in the coin-flip scenario

Kinds (substance-types)
The concept of a coin-flip; the concept of a coin's coming up Heads; the concept of a coin's being in a state of having come up Heads
The concept of your writing down the outcome of a coin-flip; the concept of your telling me the outcome of a coin-flip
The sentence "It came up Heads" (or "It came up Tails")
The value-type, word-type, or category-label "Heads" (or "Tails")
Objects (substance-instances)
Concrete objects
The event of your flipping the coin; the event of its coming up Heads; the event of its being in a state of having come up Heads; the event of your observing the coin coming up Heads
The event of your deciding to write down "It came up Heads"; the event of your deciding to tell me "It came up Tails"
The event of your writing down "It came up Heads"; the event of your telling me "It came up Tails"; your inscription of the sentence "It came up Heads"; your utterance of the sentence "It came up Tails"; your message to me "It came up Tails"
The event of my receiving the message "It came up Tails"; the event of my interpreting the meaning of the message "It came up Tails"
The piece of paper on which you write down "It came up Heads"
The marks on the paper spelling out "It came up Heads"
The value-token "Heads" (or "Tails")
Your state of knowledge before the coin was flipped; your state of knowledge after it came up Heads; my state of knowledge before you told me the coin came up Tails; my state of knowledge after you told me it came up Tails
The change in your state of knowledge produced by you observing it coming up Heads; the change in my state of knowledge caused by you telling me it came up Tails
Abstract objects
The fact that this coin came up Heads
The fact that you told me that this coin came up Tails
The proposition that this coin came up Heads
The proposition that it came up Tails
The series of related events to which this coin-flip belongs
The series of related events to which your message belongs
The subseries of events of coin-flips coming up Heads
The subseries of events of your telling me that a coin-flip came up Tails
The set of instances of the property of a coin-flip coming up Heads
The set of instances of the property of meaning that a coin-flip came up Tails
The set of properties of a coin-flip
The set of properties of a message about a coin-flip
The set of possible values of a coin-flip
The set of possible values of a message about a coin-flip

(continued)

Table 7.1 (continued)

Attributes (property-types)
The property of (a coin-flip's) coming up Heads;
the state of having come up Heads
The property of (an inscription's or utterance's) meaning that a coin-flip came up Heads (or Tails)
Modes (property-instances)
The instance in this particular case of the property of coming up Heads;
the state of this coin having come up Heads
The instance in this particular case of the property of meaning that this coin came up Heads (or Tails)
The truth-value of the proposition that this coin came up Heads (or Tails)

7.4 Probability-Theoretic Conceptions of Information

Suppose you flip a coin a large number of times, and, after each flip, you record the result—Heads or Tails—and keep a tally of the cumulative frequency of each of the two kinds of outcome. If it is a fair coin, then after a while, you will start to see a simple pattern. The running total in the Heads column will be roughly equal to the one in the Tails column. In fact, the definition of a fair coin is a coin that is equally likely to land Heads or Tails. Over time, as you keep flipping, both tallies will tend towards the same proportion (50 %) of the total number of flips.

Using the terminology of probability theory,[3] we can say that the probability p of random variable X (the flip of a fair coin) having the value x_1 (Heads) is $p(X = x_1) = 0.5$. A variable is a series of events or observations, each of which can take on any of the values specified in a set known as the domain of the variable. With a random variable, the value of any given future event cannot be predicted with certainty: all we can do is give our best estimate of the probability (i.e., the likelihood) that the next event will have one or other of the values in the domain. In the case of the fair coin-flip, the domain has two members (x_1:Heads, x_2:Tails), and the probability distribution—the plot of values of the variable X against the probabilities p with which those values occur—is uniform, in the sense that all the values of p are equal.

The value of $p(X = x_i)$ can be found by calculating the ratio of $f(X = x_i)$, the frequency of events in which variable X has the value x_i, to n, the total frequency of events. Values of p always range from 0 to 1. When $p(X = x_i) = 1$, we are in a position of absolute certainty: there is no doubt that the next event in X will take on the value x_i. Similarly, when $p(X = x_i) = 0$, we can be certain that the next event in X will not take on the value x_i. All values of p between 0 and 1 indicate varying degrees of uncertainty. We might describe the case of the fair coin-flip, with its

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[3] See, e.g., Cover and Thomas (1991) for an authoritative presentation of the mathematical material in this section.

uniform probability distribution, as one where the level of uncertainty is maximized: we have no grounds for choosing either of the two options ahead of the other as our prediction for the outcome of the next coin-flip.

Now, suppose you flip another coin a large number of times; you keep a tally of frequency of occurrence of heads and of tails as before; and, this time, instead of a 50:50 split, you see a 60:40 split. This uneven split indicates that the coin you have been flipping is not a fair coin, but a biased one, with $p(X = x_1) = 0.6$ and $p(X = x_2) = 0.4$.

7.4.1 Informativeness as Surprisal

The simplest concepts of information to be drawn from probability theory are those that result from (a) defining a measure of improbability (a.k.a. *surprisal*, or unexpectedness) as the reciprocal of p (i.e., $1/p$), (b) equating informativeness with surprisal, and (c) clarifying the nature of the relationship between the property of surprisal and the entity to which it may be attributed. In the case of the fair coin, instead of saying that Heads has a probability of 0.5 (on a scale of 0–1), we could say that Heads has a surprisal of 2 (on a scale of 0 to infinity), given that $1/p(X = x_1) = 2$. The surprisal of Tails is the same. In the case of the biased coin, the surprisal of Heads is 1.67, and that of Tails is 2.50.

It is common for surprisal to be measured in bits,[4] whereby values of improbability are expressed on a logarithmic scale, specifically as binary logarithms (where the binary logarithm of a value n, written as lb n, is the power to which 2 must be raised to obtain n). When $p = 0.5$, the value of $-\text{lb}\, p$ (which is equivalent to lb $1/p$) is 1. When $p = 0.6$, $-\text{lb}\, p = 0.74$; when $p = 0.4$, $-\text{lb}\, p = 1.32$.

One upshot would then be that (assuming we are already in a position of knowledge about the probability distribution of the values of the variable) we could give "0.74 bits" as an answer to any of these questions: "How improbable is it that the next flip of our second coin will come up Heads?" "If the next flip comes up Heads, how unexpected will that be? How surprising? How informative?" "How much information is provided by a flip of Heads?" In any given situation, the value of our answer to any of these questions will vary in inverse proportion to the probability of occurrence of the value of the variable specified in the question. In the case of the biased coin described above, a flip of Tails is more informative than a flip of Heads because it is more improbable. In the case of a variable whose probability distribution is uniform, our answer will vary in direct proportion to the size of the domain: Any roll of a fair die (where the domain consists of six values, all equally likely) is more improbable, unexpected, surprising, and therefore informative, than any flip of our fair coin.

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[4] It should be noted that the use here of "bit" as a unit of measurement is distinct from its other regular use as the name for a type of data.

There are at least four different ways of moving from such an account (of informativeness as surprisal) to an account of information.

1. One way would be to think of information as if it were *the same* property of events as surprisal. On this account, information *is* informativeness. Just as we might talk about the date or location of an event, we might talk about its information. If we were to ask, "What is the information (i.e., the informativeness) of event e_X?"—a question to which the answer would be something like "0.74 bits"—then (on this account) it is the particular surprisal of event e_X that we would be treating as information. In Lowe's terms, it would be a mode.
2. Another group of options emerge from thinking of information as whatever it is that is informative. On this account, information *has* informativeness. If we were to ask, "How informative is event e_X?"—another question to which the answer would be something like "0.74 bits"—then (on this account) there are several candidates for the thing that we would be treating as information, as follows:
    (a) It could be the outcome of event e_X—i.e., either
        (i) the category of the value produced by event e_X, such as x_1: Heads (in Lowe's terms: an attribute); or
        (ii) the particular instance of the value produced by event e_X (in Lowe's terms: a different mode).
    (b) Alternatively, it could be event e_X itself—i.e., the actual flip of the coin (in Lowe's terms: a concrete object).

7.4.2 Mean Informativeness as Entropy

A second cluster of concepts of information to be drawn from probability theory consists of those that result from (a) treating whole *variables* (i.e., series of events), rather than individual events, as the entities that have properties of interest, (b) defining a measure of *mean* improbability (a.k.a. *entropy*, or uncertainty), (c) equating mean informativeness with entropy, and (d) clarifying the nature of the relationship between the property of mean informativeness and the entity to which it may be attributed. We can calculate the entropy $H(X)$ of any random variable X by weighting the improbability (measured in bits) of every distinct outcome of an event by that outcome's probability of occurrence, and summing the weighted values. In other words, $H(X) = -\sum p(X = x_i)\ \mathrm{lb}\ p(X = x_i)$. A fair coin has an entropy of 1 bit; the biased coin in our example has an entropy of 0.97 bits.

We might wonder: What does it really mean to say that the entropy of a fair coin is greater than the entropy of a biased coin? Entropy is maximized when all the probabilities of occurrence of the possible outcomes of an event are equal: i.e., when the probability distribution is uniform. So entropy is an indicator of the extent to which those probabilities tend towards uniformity, evenness, or equality. The more unequal the probabilities, the closer the value of $H(X)$ to 0. Entropy reaches this minimal value when one of the possible outcomes has a probability of 1 (and every one of the other outcomes has a probability of 0). Consequently, entropy is often characterized as a measure of uncertainty: the more equal the probabilities of possible outcomes, the more uncertain any prediction of the outcome of the next event. The fact that the entropy of our biased coin is slightly less than the entropy of the fair coin reflects the slightly lower level of uncertainty (i.e., the slightly higher level of certainty or confidence) we would have in any prediction we might make of the outcome of the next event.

Again, there are at least four different ways of moving from such an account (of mean informativeness as entropy) to an account of information.

1. One way would be to think of information as if it were *the same* property of variables as entropy. On this account, information *is* mean informativeness. Just as we might talk about the frequency or range of a variable, we might talk about its information. If we were to ask, “What is the information (i.e., the mean informativeness) of variable *X*?”—a question to which the answer would be something like “0.97 bits”—then (on this account) it is the particular entropy of variable *X* that we would be treating as information. In Lowe’s terms, it would be a mode.
2. Another group of options emerge from thinking of information as whatever it is that is informative. On this account, information *has* mean informativeness. If we were to ask, “How informative is variable *X*?”—another question to which the answer would be something like “0.97 bits”—then (on this account) there are several candidates for the thing that we would be treating as information, as follows.
   (a) It could be the set of outcomes produced by the events comprising variable *X*—i.e., either
      (i) the set of categories of the values produced by the events comprising variable *X* (in Lowe’s terms: an abstract object); or
      (ii) the set of particular instances of the values produced by the events comprising variable *X* (in Lowe’s terms: a different abstract object).
   (b) Alternatively, it could be variable *X* itself—i.e., the actual series of coin flips (in Lowe’s terms: yet a different abstract object).

7.4.3 Mean Informativeness as Conditional Entropy

Suppose we now introduce a new element to the coin-flipping scenario. This time, instead of repeatedly flipping just one coin, we take two different coins. We flip one, record the outcome (Heads or Tails), then flip the other, and record the outcome (Heads or Tails). We do this dual-flip operation a large number of times, and end up with a tally indicating that each of the four possible combinations (Heads, Heads; Heads, Tails; Tails, Heads; and Tails, Tails) occurs on 25 % of occasions. We can say that the joint probability of the co-occurrence of the values x_1 (Heads of the first coin) and y_1 (Heads of the second coin) is $p(X = x_1, Y = y_1) = 0.25$. This result gives us good reason to believe that we have two fair coins. The joint probability distribution—the plot of the four pairs of x_i, y_i values against the probabilities p with which those values occur—is uniform.

Of course, we could do the dual-flip experiment with our two original coins, the fair one and the biased one, instead of two fair ones. In that case, the joint probability distribution is no longer uniform: the probability of two Heads, for instance, is 0.3, while the probability of one Head then one Tail is 0.2.

Armed with the probabilities of the four outcomes in either case, we can calculate a value in bits for the improbability of each outcome, i.e., $-\text{lb}\ p\left(X = x_i, Y = y_j\right)$; and we can calculate a value for the entropy of the joint distribution, i.e., $H(X, Y) = -\sum\sum p\left(X = x_i, Y = y_j\right)\ \text{lb}\ p\left(X = x_i, Y = y_j\right)$. In the case of the two fair coins, $H(X, Y) = 2$; in the case of the one fair and one biased coin, $H(X, Y) = 1.97$. As in the earlier examples with the single coins, we may consider these values of entropy as indicators of the uniformity of the probabilities of occurrence of the possible outcomes of the events in question (i.e., pairs of coin-flips), or as measures of the uncertainty of any predictions of the outcome of the next pair of flips. The fact that the joint entropy in the fair–biased case is slightly less than the entropy in the fair–fair case reflects the slightly lower level of such uniformity and uncertainty.

So far, we have been considering variables that are independent of each other. We have been assuming that the outcome of the second in each pair of coin-flips is completely uninfluenced by the outcome of the first. The next case we might consider is one where we have no reason to make such an assumption—e.g., a case in which the second variable is not a second series of coin-flips, but a reporter of the outcomes of the first series of coin-flips. Suppose we have a fair coin and a wholly reliable reporter, who always reports every outcome correctly, 100 % of the time. In other words, the conditional probability $p(Y = y_j | X = x_i)$—i.e., the probability that $Y = y_j$ given that $X = x_i$—is 1 when $y_j = x_i$, and 0 otherwise. While the probability distribution of values of Y in this case is exactly the same as that of values of Y in the case of the two fair coins, the joint distribution is quite different. For example, in the present case, $p(X = x_1, Y = y_1) = 0.5$ and $p(X = x_1, Y = y_2) = 0$. Moreover, we find that $H(X, Y) = 1$, a lower value than that found either in the fair–fair case or in the fair–biased case, indicating less uniformity in the probability distribution, and less uncertainty in any prediction that might be made of the outcome of the next flip–report pair.

Finally, suppose we have a fair coin and an unreliable reporter, who does not always report every outcome correctly. Let's say that the relevant conditional probabilities are as follows: on 90 % of the occasions when the flip is Heads, the reporter says it was Heads; on 80 % of the occasions when the flip is Tails, the reporter says it was Tails. Here we find that $H(X, Y) = 1.60$, somewhat higher than in the previous fair–reliable case, but still lower than in the fair–fair or fair–biased cases.

It is possible to interpret values of *joint* entropy as measurements of informativeness in just the same way in which values of entropy are interpretable in the cases that each involve a single variable. But it is important to appreciate that our attention would thereby be on the distribution of probabilities of *pairs* of outcomes. Values of joint entropy tell us nothing, for example, about the level of uncertainty we would have about the outcome of a report given the outcome of the corresponding flip (or about the outcome of a flip given the outcome of the corresponding report). To measure that kind of uncertainty, we can turn instead to calculating values of *conditional* entropy—either $H(Y|X)$ in the case where the outcome of the flip is known, or $H(X|Y)$ in the case where the outcome of the report is known. For example: A value for the conditional entropy of the report, given knowledge of the flip, would be calculated by weighting the conditional improbability $\left(-\mathrm{lb}\, p\left(Y = y_j | X = x_i\right)\right)$ of every distinct flip–report outcome-pair by that outcome-pair's probability of occurrence $\left(p\left(X = x_i, Y = y_j\right)\right)$, and summing the weighted values. In other words, $H(Y|X) = -\sum\sum p\left(X = x_i, Y = y_j\right)$ lb $\left(p\left(Y = y_j | X = x_i\right)\right)$.

In the fair–fair case, the value of $H(Y|X)$ is 1 bit, reflecting the uniformity of the distribution of conditional probabilities; in our fair–biased case, it is slightly lower (0.97 bits), reflecting the slight reduction in uniformity. In the fair–reliable case, in contrast, it is zero, reflecting the situation of minimum uncertainty; while in our fair–unreliable case, it is back up to 0.60 bits.

7.4.4 Mean Informativeness as Mutual Information

What implications does this demonstration of a method of characterizing the uniformity of a joint or conditional probability distribution have for conceptions of information? Well, just as in the case of the single coin-flip, we might choose to equate mean informativeness with conditional entropy, and move from there to a clear specification of information either (a) as something that *is* informativeness, or (b) as something that *has* informativeness. In the case of a pair of variables, however, there is yet a further possibility, which is to equate informativeness with a quantity that has indeed generally come to be known as *mutual information*. Mutual information is given by the formula $I\left(X;Y\right) = \sum\sum p\left(X = x_i, Y = y_j\right)$ lb $\left(p\left(X = x_i, Y = y_j\right) / \left(p(X = x_i)\, p\left(Y = y_j\right)\right)\right)$, and can be interpreted as a measure of the extent to which each variable is dependent on the other, of the extent to which knowledge of the values of one reduces uncertainty in predictions of the values of the other, and of the extent to which each variable tells us about the other. The relationships among entropy, joint entropy, conditional entropy, and mutual information—including the fact that $I\left(X;Y\right) = H(X) + H(Y) - H\left(X, Y\right)$—are indicated diagrammatically in Fig. 7.2.

In both the fair–fair and the fair–biased case, $I(X;Y) = 0$, since the two variables are independent, and knowledge of the value of one is of no help in predicting the value of the other. But in the fair–unreliable case, $I(X;Y) = 0.40$, and in the fair–reliable case, $I(X;Y) = 1.00$, indicating successively greater degrees of dependence, and greater amounts of reduction in our uncertainty when we base our predictions of values of one on knowledge of values of the other. Indeed, in the fair–reliable case, mutual information is maximized, as uncertainty (expressed in the form of

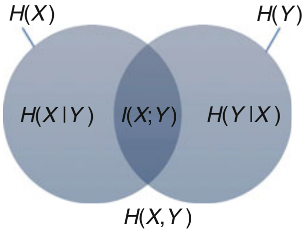

Fig. 7.2 $I(X;Y) = H(X) + H(Y) - H(X, Y)$

Table 7.2 Conceptions of informativeness

Conception of informativeness	Formula
Surprisal	$-\text{lb } p(X = x_i)$
Entropy, $H(X)$	$-\sum p(X = x_i) \text{ lb } p(X = x_i)$
Conditional entropy, $H(X\|Y)$ or $H(Y\|X)$	$-\sum\sum p\big(X = x_i, Y = y_j\big) \text{ lb } \big(p\big(X = x_i \| Y = y_j\big)$ or $-\sum\sum p\big(X = x_i, Y = y_j\big) \text{ lb } \big(p\big(Y = y_j \| X = x_i\big)$
Mutual information, $I(X;Y)$	$\sum\sum p\big(X = x_i, Y = y_j\big) \text{ lb } \big(p\big(X = x_i, Y = y_j\big) / \big(p(X = x_i)\, p\big(Y = y_j\big)\big)\big)$

values of conditional entropy, $H(X|Y)$ and $H(Y|X)$) is reduced to zero. The inverse relationship between entropy (as a measure of uncertainty) and mutual information (as a measure of reduction in uncertainty) is reflected in the "difference in sign" in the formulae of each—negative in the former, and positive in the latter.

A third cluster of concepts of information to be drawn from probability theory, then, consists of those that result from (a) treating *pairs* of variables, rather than single variables, as the entities that have properties of interest, (b) defining a measure either of mean conditional improbability (a.k.a. *conditional entropy*) or co-dependency (a.k.a. *mutual information*), (c) equating mean informativeness with either of those measures, and (d) clarifying the nature of the relationship between the property of mean informativeness and the entity to which it may be attributed.

7.4.5 Informativeness and Information

We now have four distinct conceptions of informativeness, summarized in Table 7.2.

Using *surprisal*, we can measure the unexpectedness of the value of a given event. If we chose to equate informativeness with surprisal, we would be proposing that the more unexpected a value, the more informative it is. Using *entropy*, we can measure the uniformity of the distribution of probabilities of occurrence of the possible outcomes of a given variable. If we chose to equate mean informativeness with entropy, we would be proposing that the more uniform such a distribution, the more informative it is. Using *conditional entropy*, we can measure the uniformity of the distribution of conditional probabilities of occurrence of the possible outcome-pairs of a given variable-pair. If we chose to equate mean informativeness with

Table 7.3 Additional phenomena of interest in the coin-flip scenario

The probability of the coin's coming up Heads; the unexpectedness of it coming up Heads
Your uncertainty as to whether it would come up Heads, or Tails
The fraction of messages you send that are true (i.e., accurate representations of fact)
The fraction of messages I receive that are true
Your reliability in accurately representing facts in general, and/or coin-flips in particular
The fraction of content of messages sent that is not received
The fraction of content of messages received that is not sent
The reliability of the channel across which messages are sent
The probability of your telling me this coin came up Tails; the unexpectedness of your telling me it came up Tails
My uncertainty as to whether you would tell me it came up Heads, or Tails
My uncertainty as to whether it came up Heads, or Tails

conditional entropy, we would be proposing that the more uniform such a distribution, the more informative it is. Using *mutual information*, we can measure the co-dependency of two variables. If we chose to equate mean informativeness with mutual information, we would be proposing that the more co-dependent a pair of variables, the more informative each is.

In each of these cases, as we have seen, there are several different ways of moving from the account of informativeness that each provides to an account of information. For example, if we equate informativeness with information, then we might conclude that instances of information are property-instances (i.e., modes in Lowe's ontology) such as the particular surprisal of a particular event. If we decide instead that informativeness is a property of information, then we might conclude (by choosing among various possibilities) that instances of information are substance-instances (i.e., concrete objects in Lowe's ontology).

Returning to the list of phenomena involved in our original coin-flip scenario, some of the entries that should now be added to the "Modes" category are identified in Table 7.3.

7.5 The Ontological Commitments of Information Theorists, I

A comprehensive review of the literature on the nature of information would fill a book. Others (see, e.g., Bates 2010; Capurro and Hjørland 2003; Case 2012; Floridi 2003) have provided excellent shorter overviews. I do not intend to take either of these routes here. Instead, I am going to focus on a sample of convenience that I will simply assume (whilst I am aware of the risks of doing so) to be representative of the larger population. If you type "What is information?" (complete with the opening and closing quotation marks) into Google Scholar, you find a lot of good stuff. The highlights are summarized in Table 7.4: 18 papers, published between 1955 and 2012, with the title "What is information?"

Table 7.4 Contributions to the literature on “What is information?,” 1955–2012

Rapoport, A. 1955. What is information? *Synthese* 9(1): 157–173.
Contribution type: A (single existing: Shannon information)
Author’s discipline: Mathematics
Source’s discipline: Epistemology
LIS authors cited: –

Drum, D.D. 1956. What is information? *The Speech Teacher* 5(3): 174–178.
Contribution type: A (single existing: Shannon information)
Author’s discipline: Speech communication
Source’s discipline: Speech communication
LIS authors cited: –

Stonier, T. 1986. What *is* information? In *Research and development in expert systems, III: Proceedings of expert systems ’86: The sixth annual technical conference of the British Computer Society Specialist Group on expert systems, Brighton, 15–18 December 1986*, ed. M. Bramer, 217–230. Cambridge: Cambridge University Press.
Contribution type: C (new)
Author’s discipline: Biology
Source’s discipline: Computer science
LIS authors cited: –

Israel, D., and J. Perry. 1990. What is information? In *Information, language, and cognition*, ed. P.P. Hanson, 1–19. Vancouver: University of British Columbia Press.
Contribution type: C (new)
Authors’ discipline: Philosophy of language
Source’s discipline: Cognitive science
LIS authors cited: –

Sveiby, K.-E. 1994. *What is information?* Sveiby Knowledge Associates. http://www.sveiby.com/articles/Information.html. Accessed 1 Aug 2012.
Contribution type: B (review)
Author’s discipline: Knowledge management
Source’s discipline: –
LIS authors cited: –

Hillman, C. 1995. *What is information?* Seattle: Department of Mathematics, University of Washington. http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.51.8223. Accessed 1 Aug 2012.
Contribution type: C (new)
Author’s discipline: Mathematics
Source’s discipline: –
LIS authors cited: –

Lagache, A. 1997. What is information? In *Signals and images: Selected papers from the 7th and 8th GIRI meeting, held in Montpellier, France, November 20–21, 1993, and Jerusalem, Israel, December 10–11, 1994*, ed. M. Bastide, 279–292. Dordrecht: Kluwer Academic.
Contribution type: A (single existing: information as signification)
Author’s discipline: Philosophy
Source’s discipline: Homeopathy
LIS authors cited: –

(continued)

Table 7.4 (continued)

Rowley, J. 1998. What is information? *Information Services and Use* 18(4): 243–254.
Contribution type: B (review)
Author's discipline: LIS
Source's discipline: LIS
LIS authors cited: Bawden, Brier, Brookes, Buckland, Capurro, Cronin, Davenport, Eaton, Fairthorne, Hannabuss, Hayes, Ingwersen, Kaye, Kuhlthau, Rowley, Ruben, etc.

Chmielecki, A. 1998. What is information? An ontological approach. In *Proceedings of the twentieth world congress of philosophy, Boston, August 10–15, 1998*, ed. A.M. Olson. http://www.ifsid.ug.edu.pl/filozofia/pracownicy/a_chmielecki/doc/teksty_w%20_jezyku_angielskim/what%20is%20information.pdf. Accessed 1 Aug 2012.
Contribution type: C (new)
Author's discipline: Ontology
Source's discipline: Philosophy
LIS authors cited: –

Sholle, D. 1999. What is information? The flow of bits and the control of chaos. Paper presented at the media in transition conference, Cambridge, MA, October 8, 1999. http://web.mit.edu/m-i-t/articles/sholle.html. Accessed 1 Aug 2012.
Contribution type: B (review)
Author's discipline: Mass communication
Source's discipline: Media studies
LIS authors cited: –

Lombardi, O. 2004. What is information? *Foundations of Science* 9(2): 105–134.
Contribution type: B (review)
Author's discipline: Philosophy of science
Source's discipline: Philosophy of science
LIS authors cited: –

Harms, W.F. 2006. What is information? Three concepts. *Biological Theory: Integrating Development, Evolution, and Cognition* 1(3): 230–242.
Contribution type: B (review)
Author's discipline: Philosophy
Source's discipline: Biology
LIS authors cited: –

Konorski, J., and W. Szpankowski. 2008. What is information? Paper presented at ITW'08: The IEEE information theory workshop, Porto, May 5–9, 2008. http://www.cs.purdue.edu/homes/spa/papers/info08.pdf. Accessed 1 Aug 2012.
Contribution type: C (new)
Authors' disciplines: Telecommunications/Computer science
Source's discipline: Information theory
LIS authors cited: –

Díaz Nafría, J.M. 2010. What is information? A multidimensional concern. *TripleC: Cognition, Communication, Co-operation* 8(1): 77–108. http://www.triple-c.at/index.php/tripleC/article/view/76. Accessed 1 Aug 2012.
Contribution type: B (review)
Author's discipline: Computer science/Philosophy of science
Source's discipline: Information society studies
LIS authors cited: Brier, Capurro

(continued)

Table 7.4 (continued)

Rocchi, P. 2011. What is information? Beyond the jungle of information theories. *Ubiquity*, March 2011, article no. 1. http://dx.doi.org/10.1145/1959016.1959017. Accessed 1 Aug 2012.	
Contribution type:	B (review)
Author's discipline:	Computer science
Source's discipline:	Computer science
LIS authors cited:	–
Yapp, C. 2011. What is information? *ITNOW* 53(2): 18.	
Contribution type:	Short paper
Author's discipline:	Information technology
Source's discipline:	Information technology
LIS authors cited:	–
Logan, R.K. 2012. What is information? Why is it relativistic and what is its relationship to materiality, meaning and organization. *Information* 3(1): 68–91. http://www.mdpi.com/2078-2489/3/1/68. Accessed 1 Aug 2012.	
Contribution type:	B (review)
Author's discipline:	Physics
Source's discipline:	Information science and technology
LIS authors cited:	Losee
Barbieri, M. 2012. What is information? *Biosemiotics* 5(2): 147–152.	
Contribution type:	A (single existing: biological information)
Author's discipline:	Embrylogy
Source's discipline:	Biosemiotics
LIS authors cited:	–

The LIS student, perhaps raised on a diet of Bates, Bawden, and Buckland, with substantial helpings of Belkin, Briet, and Brookes, might be forgiven for failing to recognize not just the names of the authors represented in Table 7.4, but even the titles of the journals and conferences. With the single exception of Rowley's 1998 article in *Information Services and Use*, it is difficult to imagine any of these papers being routinely treated as contributions to the LIS literature. Few have been cited to any great extent by LIS authors; and similarly few contain citations to LIS sources. Yet, just as we might expect, every one is an intriguing and provocative contribution to the literature on the nature of information. My intention in this section and the next is to examine the conceptions of information that are developed in a small, purposive sample of these papers, with the aims of clarifying the nature of the relationships among these conceptions, and demonstrating the potential value of the ontological approach outlined above.

Before we focus on a couple of the most recent articles from the set listed in Table 7.4, it is worth taking a look at a few of the older contributions in a little more detail: one from the 1950s (Rapoport's) that introduces its readers to the theory (Shannon's) that has had by far the greatest impact on the development of conceptions of information in the world beyond LIS; one from the 1980s (Stonier's) in which the author develops one of the first serious accounts of information as a physical entity; and another from the 1990s (Lagache's) that presents a compelling version of the semiotic theory of information that is widely admired in LIS.

7.5.1 Rapoport (1955)

The conception of information that Shannon (1948) developed as a core element in his mathematical theory of communication (and whose origins have been traced to precursors such as Hartley (1928)) is effectively summarized in the first "What is information?" (WII) in our list, written more than half a century before the most recent contributions such as Logan's (2012).[5]

Anatol Rapoport (Russian-born American; 1911–2007) was a mathematician who made important contributions to game theory, decision theory, social network analysis, and general systems theory. In his paper (Rapoport 1955), Shannonian information theory is introduced from the outset as a branch of probability theory, and information is defined as "the improvement of one's chances of making the right guess" (p. 158) in situations of a certain kind—viz those in which the probability of one's correctly predicting the value of one random variable is affected by one's already knowing the value of another random variable. This probability can be calculated by analyzing the properties of the joint probability distribution of the two variables. The amount of information shared by the two variables—i.e., the *mutual information* of the joint distribution—is defined as the extent to which each tells about (or depends on) the other.[6]

Rapoport (1955) considers the potential for applying this conception of information to the solution of problems in several scientific fields—communications engineering, linguistics, physics, and biology—claiming that Shannon's information theory provides "an altogether new way of measuring the amount of information in a message" (p. 158). The idea is that the sources (senders) and targets (receivers) of messages are to be treated as random variables, and that the probability distribution of the values of the signals comprising the messages received by a given target is to be compared with the probability distribution of the values of the signals comprising the messages sent by a given source. The amount of information (on average) in a message sent by source X to target Y is defined as the mutual information of the joint distribution—i.e., the extent to which the two variables depend on each other, or (another way of describing the same quantity) the extent to which our uncertainty about the values of the signals received would be reduced by prior knowledge of the signals sent.

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[5] Rapoport was by no means the first to articulate the value of Shannon's theory in this way. Among other summarizations, Warren Weaver's (1949) introduction to a volume in which Shannon's 1948 paper was reprinted has been especially influential.

[6] See the discussion of mutual information in Sect. 7.4.4 above.

This technical definition of information is contrasted by Rapoport (1955) with that implicit in the old way of measuring the amount of information in a message, “known ever since messages were invented” (p. 158), whereby a message is assumed to carry “more or less information in it depending on the state of knowledge of the recipients” (p. 158). Instead of comparing the contents of individual messages with the contents of individual persons’ minds, the new suggestion (i.e., Shannon’s) is that we compare probability distributions of the values of signals sent and signals received.

Following Weaver (1949) and others, Rapoport (1955) notes the opportunity provided by information theory to extend the notion of mutual information so that we may talk not only about the average amount of information per message sent by a given source to a given target, but also the amount of information in a single message. All other things being equal, the amount of such “self-information” in a message—i.e., the message’s *surprisal*—increases as the size of the repertoire from which the message is selected increases.[7] The more messages you (as a prospective sender of a message) have to choose from, the less chance a receiver has of accurately predicting what message you will choose to send, and your “information giving capacity” increases (p. 159).

In its application to communications engineering, information theory provides ways of (for example) estimating the effects of noise on the accurate reception of signals, and calculating the limits at which communication channels may be expected to perform. In linguistics, information theory may be used to measure the amount of redundancy in a natural or coded language. Turning his attention to applications in physics, Rapoport (1955) notes that “the formula for the amount of information … looks exactly like the formula for *entropy* in statistical mechanics” (p. 168), and insists on the significance of this mathematical (rather than merely metaphorical) analogy: “Such analogy is evidence of similar *structure* in two or more classes of events, and a great deal can be deduced from such similarity” (p. 168).

An explanation of the relationship between information and entropy requires some familiarity with related concepts in thermodynamics, i.e., the study of the physical laws that govern the conversion of energy from one form to another and the flow of energy from one object to another.[8] These laws are expressed in terms of quantitative relationships among amounts of work, energy, heat, temperature, and entropy. *Work* is the action of a force on an object, and *energy* is the ability of an object to do work. Both are measured in joules. Energy has two forms: potential energy, which an object has as a consequence of its position, shape, or state; and kinetic energy, which an object has as a consequence of its motion. *Heat* is the flow of energy from one object to another as a result of difference in *temperature*: when heat flows, the object from which heat flows is said to be at a higher temperature; when no heat flows between two objects, their temperatures are equal. In the latter

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[7] See the discussion of surprisal in Sect. 7.4.1 above.

[8] See, e.g., Pitzer (1995) for an authoritative presentation of the principles of thermodynamics.

case, the objects' energy is said to be unavailable for doing work. *Entropy* is the unavailability of energy in a system, measured in joules per kelvin, and is maximized when the temperatures of all objects in the system are equal. The second law of thermodynamics specifies that the entropy of any closed system—i.e., the degree to which the temperatures of objects in the system are uniform—increases over time.

The concept of entropy was introduced in 1865 by Rudolf Clausius (German physicist; 1822–1888), who had already formulated the second law of thermodynamics in 1850. One formula for calculating entropy—$S = k \ln W$—is named after Ludwig Boltzmann (Austrian physicist; 1844–1906). Here k is the Boltzmann constant, equal to 1.38062×10^{-23} J/K, and W is the number of distinct ways in which the atoms and molecules comprising the system may be arranged while preserving the system's temperature, i.e., the number of possible microstates of the system that are consistent with its current macrostate. This formula assumes that each microstate is equally probable. A generalization of Boltzmann entropy is due to J. Willard Gibbs (American scientist, 1839–1903): $S = -k \sum p \ln p$, where p is the probability of occurrence of a microstate. The similarity in form of this formula to that introduced in Sect. 7.4.2 above (and contrasted with surprisal and mutual information in Table 7.2 above) should be noted.

It is often argued—as Rapoport (1955) does in his WII—that entropy may be viewed as a measure of the *disorder* of a system, in the sense that a higher value of entropy indicates a greater number of possible configurations of the system at the microscopic level. But this characterization of entropy can be confusing, especially when it is considered that, at the macroscopic level, higher entropy indicates greater uniformity, homogeneity, and equilibrium.

In summary: In Rapoport's (1955) presentation, readers are introduced to the concepts (if not the precise terms) of surprisal, entropy, and mutual information; and we are invited to consider these as measures of *amounts* of information, with the implication that information is thus to be equated with informativeness. On this view, information is not something that *has* informativeness: it *is* the informativeness of something. In Lowe's (2006) terms, instances of Rapoport's information are modes.

7.5.2 Stonier (1986)

Our second WII (what is information?) of interest is Tom Stonier's (1986). Stonier (1927–1999) was a German-born biologist, active in the U.S. and in the U.K., who made celebrated contributions to STS (science, technology, and society) and peace studies. He wrote a trilogy of books (Stonier 1990, 1992, 1997) developing a "general theory of information" based on the somewhat controversial idea that entropy can be negative.

Stonier (1986) begins his WII by talking about information in a rather conventional sense, as something that people "absorb" every time they talk or read, that can be stored outside the human brain, and (as "raw data") is processed not just by human brains but by "information machines" (i.e., computers). He notes that the science of thermodynamics emerged only when we had experience with "energy machines" (i.e., steam engines), and expresses frustration that, in his view, we still don't have an equivalent "science of information" that allows us to understand the "actual properties of information such as function, structure, dynamic behaviour and statistical features ..." (Stonier 1986: 220, quoting Scarrott 1986). It then becomes clear that Stonier is seeking to treat information as "a property of the universe"—i.e., a physical entity in its own right, analogous to matter and energy, and perhaps even present in particulate form as infons.

Stonier's (1986) conception of information is of a quantity I whose values can be calculated using the formula $I = 1/W$, where W has the same meaning as it does in Boltzmann's formula for entropy. In other words, Stonier's information is the *reciprocal* of the number of possible microstates of the system that are consistent with its current macrostate, and the relationship between entropy and Stonier's information is given by $S = k \ln c/I$, where c is a constant that may vary between systems of different types.

Stonier (1986) is very clear about the difference between his conception of information and the one he attributes to Shannon: The two concepts are "diametrically opposed" (p. 222). A system in a high-entropy state, i.e., one characterized by a uniformity of temperature (at the macroscopic level) and a high level of atomic and molecular disorder or randomness (at the microscopic level), is one that exhibits a large amount of (what Stonier characterizes as) Shannon information, but a small amount of Stonier information. Conversely, if a system is highly ordered, highly organized, highly differentiated, highly complex, and highly improbable—like organic molecules and living cells are—then its Stonier information content is high.[9] Indeed, Stonier suggests that it is possible for the most complex (and thus informative) systems to be characterized by values of entropy that descend below 0, i.e., values of negative entropy. A case such as this, however, would require a value for W lower than 1, and Stonier leaves it quite unclear how such a value could be generated. It is important to recognize, moreover, that Stonier's characterization of Shannon's "information" as equivalent to entropy is a narrow view in which other concepts of information derivable from probability theory (mutual information in particular; see Fig. 7.2 and Table 7.2) are ignored.

Stonier's (1986) conception of information is the centerpiece of his proposal for a new "information physics" in which matter, energy, and information are recognized as the three basic components of the universe. Any system that is nonrandom in its structure—i.e., any system that is ordered in some way—contains information: "What mass is to the manifestation of matter, and momentum is to energy, organization is to information" (p. 224). Just as different forms of matter (i.e., solid, liquid, gas) contain different amounts of energy, different forms of energy (e.g., mechanical energy, chemical energy, electrical energy) contain

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[9] The idea that information is a quantity equivalent to the reciprocal of entropy is due to Norbert Wiener (1948), whom Stonier does not cite.

different amounts of information: "[J]ust as ice, liquid water, and steam represent matter whose form is determined by the amount of energy contained within it, so may the various forms of energy reflect the nature and amount of information contained within them." (p. 224).

One of the implications of Stonier's (1986) inclusion of information in the list of the universe's basic entities implies that "... every existing equation describing the interaction between matter and energy ... needs to be re-examined ..." (p. 225). Work is to be reconceptualized as a process that may result in a change in a system's information content, as well as (or instead of) a change in a system's energy content. "Other things being equal, the information content of a system is determined by the amount of work required to produce the information or organisation exhibited by the system" (p. 224). Stonier goes so far as to propose that light contains information, and that a photon is not itself an elementary particle; rather, it is made up of two elementary components: an energon (i.e., a quantum of pure energy), and an infon (i.e., a quantum of pure information). "[Infons] would not show up in any traditional physics experiment since such particles would possess neither mass nor energy—they would, however, manifest their effect by changes in organisation" (p. 227).

The postulation of the existence of quantum phenomena of any kinds raises some tricky issues for ontologists.[10] Certainly it is not immediately obvious where, in Lowe's (2006) four-category ontology, particles of pure information lacking mass and energy should be placed; but the categories of mode and object are two possibilities. Clarifying the ontological status of information is a live issue for those contemporary theorists who, following Stonier and others, advocate for conceptions of information as some sort of structuring or organizing principle exercised upon matter and energy.[11]

7.5.3 Lagache (1997)

Our third WII of interest is by Agnès Lagache (d. 1999), who was a philosophy professor at the Lycée Carnot in Paris, and frequent collaborator with immunology professor Madeleine Bastide on projects relating to the theoretical foundations of homeopathy. Her WII (Lagache 1997), a paper presented at the 8th meeting of the Groupe International de Recherches sur l'Infinitésimal (GIRI; the International Research Group on Very Low Dose and High Dilution Effects) in 1994, gives a

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[10] See, e.g., French and Krause (2006).

[11] Marcia Bates (2005, 2006), for example, grapples with this issue; see Furner (2010: 178–181) for a discussion. I am grateful to Tom Dousa for the insight that conceptions like Stonier's are somewhat comparable to the "forms" of Aristotelian and Scholastic philosophy, which likewise give structure to otherwise unformed matter; see Capurro (1978) for a review of such ideas.

compelling account of information as the meanings of signs—in virtue of which her conception finds its natural habitat among the *semiotic* family (identified in Sect. 7.2 above) that is well-established in the LIS community.[12]

Lagache (1997) begins her discussion (p. 284) with a statement of Gregory Bateson's "general principle" of information as "a difference which makes a difference" (Bateson 1972), and proceeds to reconcile this definition with a semiological view of the central role of information in the process of signification or representation. The main elements of this conception are as follows (Lagache 1997):

- Signs are those phenomena that are informative, i.e., those "differences" (i.e., distinctions between an "element" and the "structure" in which it appears) that "make a difference" by becoming "significant" (i.e., literally, signifying or representing).
- Signs exist on two levels, one material and one interpretive: "The semantic object [has] a double nature: it belongs to the level of things as drawing, voice, written letters ..., but it [also] belongs to the level of interpretation ... " (p. 290).
- Material objects exist as signs only when they are being interpreted. "Sartre said that paintings in an art gallery don't exist during the night and closure: at these moments, they are only canvas, oil and such stuff. They exist as paintings when they are watched. In the same way, ideograms or letters don't exist as signs without a reader" (p. 289).[13]
- Information occurs when representation does, and specifically when the products of representation are interpreted. "The world of information begins when dealing not with the thing, but with a representation of things" (p. 285).
- Information is both a process and the result of that process: "... [Information] is [the] very event which happens between levels, which goes from things to reading, the very passage itself. Sense is an emigrant: process and result are the same" (p. 290).
- Information is not material. "... [A] piece of information is not an object, though having generally a medium." (p. 284). "... [N]othing is information by itself; information is not an object, and doesn't *subsist in itself and for itself*, according to the classical definition of substance" (p. 289, emphasis in original). "... [A]lthough it does exist, information is not a substance" (p. 290).

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[12] See, e.g., Qvortrup (1993).

[13] The similarity of this argument to Suzanne Briet's (1951) explanation of the distinction that should be made between the documentary status of an antelope in the wild and that of an antelope in a zoo (an explanation that is well-known in LIS thanks to the glosses provided by Michael Buckland and others; see, e.g., Buckland 1991) is striking, especially given Briet's characterization of documents as signs (*indices*). However, it should be noted that Sartre's paintings take on a sign-role only when they are being regarded; whereas, once it enters the zoo's collection, Briet's antelope remains a document even when nobody is looking at it.

- Information is subjective, in the sense that the meaning of any given sign is dependent on its interpreter. "Information is in the receiver. … The receiver is necessarily active: information arises from his reading. He creates it." (p. 289).[14]
- The interpretation of a given sign is influenced by context: "… [T]he world of information is the determinism of context: the original role that a given element plays according to the structure in which it appears. … A lost jigsaw-piece in a children's room has no meaning … Putting it in its jigsaw's frame with the other pieces makes arise a new meaning … Sense is an emigrant, the new and impalpable dimension which arises not from objects, but from the network of woven relations around objects" (p. 284).
- Information by itself is not observable. "What we actually observe is the informative effect on a receiver" (p. 289).
- The more informative a sign, the better: "… [A] criterion of good art would be its informative effect on art lovers" (p. 288).
- Other conceptions of information miss the target completely and disastrously. "[The] fantastic semantic capacity of living beings cannot remain for ever relegated out of science" (p. 290).

Lagache (1997) identifies several kinds of signs:

(a) At "the most primary level" of representation, there are *images*, which are "similar to the thing, but maintaining a constitutive difference with things" (p. 286), e.g., the representation of a man's hand formed by the man's dipping his hand in paint and then pressing that hand on a wall: "… [I]mages … are signifiers, that is a concrete sign of the thing, but stand for an equivalent of the thing; there is no transformation, just … an *alleviation* of the presence of the thing. We see this hand, and we just know that a man dropped in there" (p. 285).

The interpretation of an image depends on the viewer's previous experience. "… [T]he informative ability of such an image is dependent upon a previous and already known lexical register: the receiver, the reader of the image must have a referent to understand it. Each image is different, and does not inform about anything else than itself; the receiver must already have encountered the thing, or must have a memorized referent to be able to read it" (p. 285).

(b) Then there are *tracks*, e.g., the representation of a man's hand formed by the man's laying his hand on a wall, spreading powder all around it, and then removing the hand: "… [T]he original informative power of tracks comes from the function of absence, included into the signifier. … We don't see a hand, we *see an absent hand*, that is the mere genius of semantic objects" (p. 287, emphasis in original).

(c) There are *analogic signs*, i.e., voiced names for things: "… [B]efore becoming an alphabet, written signs went through an intermediary state of syllabication.

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[14] Lagache (1997: 284) also quotes Merleau-Ponty, from his *Phenomenology of perception* (1945): "The mere presence of a living being transforms the physical world, makes appear here foods, there hiding places, and imparts to the stimuli a meaning they had not."

the thing but to the vocalization of its noun. There is an analogical transfer from the reference to the thing, to the corporal event of vocalizing its noun" (p. 288).

(d) And finally there are *symbolic signs*, i.e., written words, where the "break-up between signified and signifier" is complete: "Letters are completely symbolic: they are no more images; they refer to the register of verbal language as supporting the whole necessary referents" (p. 287).[15]

Strictly speaking, what Lagache calls mere signals (e.g., "a pheromone amongst butterflies," p. 285) are not informative, because they do not have a representational function, and are not interpretable. As material objects, signals play only a "determinist" (i.e., causal) role.

For Lagache, then, signs are what are informative: informativeness is a property of signs. But signs are not themselves information, since information is not what has informativeness: information *is* informativeness. The information (i.e., the informativeness) of a sign is its meaning. In Lowe's (2006) terms, instances of Lagache's information are modes. While the two are quite different from each other in their content, the Shannonian conception (based on probability theory) and the Lagachian conception (based on semiotics) are nevertheless surprisingly similar in the ontological status they assign to information.

7.6 The Ontological Commitments of Information Theorists, II

In the context of the issues raised thus far, two of the journals represented in the list in Table 7.4 are of particular interest. Given their relative lack of visibility in LIS at the present time, it might be useful to provide a few contextual details, before we take a look at two more WIIs appearing very recently in their pages.

Information is the straightforward title of a relatively new[16] online, open-access, peer-reviewed journal published quarterly by MDPI[17] out of Basel, Switzerland. It is

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[15] Because Lagache does not use the standard semiotic terminology (due to Peirce; see, e.g., Atkin 2010) of icon, index, and symbol, it is not immediately clear how the first three of her four kinds of signs should be mapped to a Peircean framework. For example, is the handprint an icon (referring to its object through similarity), or an index (referring to its object through a physical connection)?

[16] Its first volume was published in 2010.

[17] From MDPI's website at http://www.mdpi.com/about/history, we learn that, at the time of its founding in 1996 as a non-profit institute for "the promotion and preservation of the diversity of chemical compounds" and as the publisher of the electronic journal *Molecules*, MDPI originally stood for "Molecular Diversity Preservation International"; that it now stands for "Multidisciplinary Digital Publishing Institute"; and that the organization now publishes more than 70 open-access journals in a variety of (mainly) scientific fields, many of which are financed by collecting "article processing charges" from journal articles' authors.

described on its website[18] as a journal of "information science and technology, data, knowledge and communication," and further specifics of its scope are indicated by the following list of subject areas: "information technology (IT) and science; quantum information; information theory, systems theory, cybernetics; communication theory and communication technology; information security; information society; data management, information systems; data mining, data, knowledge; languages, semiotics; information processing systems; information and computation; information and artificial intelligence; information in society and social development; information and intelligent agents; problems of information security; information in organizations and knowledge management; information processes and systems in nature."

Information's founding editor-in-chief is Mark Burgin,[19] formerly of Kiev State University and since 1998 a visiting scholar in the mathematics department at UCLA.[20] Its editorial board includes a mix of, on the one hand, scholars working in fields that are somewhat related to library and information science (LIS), such as information use, scientometrics, and information ethics, and on the other, researchers whose names may be less familiar to an LIS audience, including computer scientists and physicists.[21] *Information* has published several "special issues"—i.e., virtual issues made up of articles that are focused on a common theme but that may be scattered across different regular issues. One special issue on "What is information?," edited by Burgin, comprised ten papers published in 2010–11; another collected fourteen "Selected papers from FIS 2010 Beijing,"[22] edited by Pedro C. Marijuán in 2011–12; a third brought together eight papers on "Information and energy/matter," edited by Gordana Dodig-Crnkovic in 2011–12; and a fourth on "Information: Its different modes and its relation to meaning," edited by Robert Logan, was (at the time of writing, in July 2012) still open to submissions.

In a related vein, *TripleC: Cognition, Communication, Co-operation* is a transdisciplinary, peer-reviewed, open-access journal "for a global sustainable information society,"[23] founded in 2003 by systems scientist Wolfgang Hofkirchner (Unified Theory of Information [UTI] Research Group, Vienna, Austria) and currently edited

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[18] See http://www.mdpi.com/journal/information/about/

[19] See http://www.mdpi.com/journal/information/editors

[20] See http://www.math.ucla.edu/~mburgin/fl/cv.htm

[21] Information use: Suzie Allard and Kizer Walker; scientometrics: Loet Leydesdorff and Lokman Meho; information ethics: Rafael Capurro, Luciano Floridi, and Herman Tavani; computer science: Gordana Dodig-Crnkovic, Lorenz Hilty, and Paul Vitányi; physics: Giorgio Kaniadakis, Andrei Khrennikov, and Robert Logan; see http://www.mdpi.com/journal/information/editors

[22] FIS 2010: Towards a New Science of Information (Beijing, China, August 20–23, 2010), co-chaired by Hua-Can He, Pedro Marijuán, and Wolfgang Hofkirchner, with Burgin, Floridi, and Logan among the members of its international advisory board, was the Fourth International Conference on the Foundations of Information Science; see http://bitrumagora.wordpress.com/2010/03/17/2010fis-conference/

[23] See http://www.triple-c.at/index.php/tripleC/index

by media theorist Christian Fuchs (Uppsala University, Sweden).[24] It provides a forum for the discussion of "the challenges humanity is facing in the information society today," and its scope is defined by the following list of thematic areas: "information society studies, media and communication studies, internet research, new media studies, social informatics, information and communication technologies & society; science and technology studies (STS), technology assessment, design science; social sciences, economics, political economy, communication studies; science of information, information studies, cognitive science, semiotics; philosophy, humanities, arts; with a special interest in critical studies ..." Submissions to the journal are required to show how findings contribute to "the illumination of conditions that foster or hinder the advancement of a global sustainable and participatory information society."[25]

TripleC's editorial board includes several scholars of information studies; several who also sit on *Information*'s board; several members of the UTI Research Group; and several who served on the advisory board for FIS 2010.[26] In other words, there is much overlap among the memberships of these bodies, indicating the existence of a relatively small but well-defined and cohesive research community. *TripleC* has published many papers in which the question "What is information?" is a central topic, including articles by Burgin, Marijuán, Brenner, Collier, and (in a 2009 special issue on "What is really information? An interdisciplinary approach") Capurro, Floridi, Fleissner, Fuchs, Díaz Nafría, and Hofkirchner. A 2011 special issue on "Towards a new science of information" collected 31 further contributions to FIS 2010, adding to the 14 published in *Information*.

Few of the papers published in the special issues of *Information* and *TripleC* cite the LIS literature or (as yet) attract citations from LIS. Why might this be? Is there a sense in either camp that the other has little to offer? Or a lack of awareness of each other's existence? One way to address this issue would be to conduct a comprehensive review of the kinds of answers to the "What is information?" question that are provided in the *Information*–*TripleC*–UTI–FIS community, and to determine how different they are from those that are routinely gathered up in the surveys that are read and cited by LIS scholars. It is not my intention to do that

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[24] Hofkirchner is current president of the UTI Research Group; Fuchs is a member of its executive board. UTI Research Group focuses on "the role of information, communication, media, technology, and culture in society," contributing to "information science, communication and media studies, and science and technology studies"; see http://uti.at/

[25] See http://www.triple-c.at/index.php/tripleC/about/editorialPolicies

[26] Information studies: Ron Day, Michel Menou, Alice Robbin, and Dan Schiller; *Information* editorial board: Burgin, Capurro, Dodig-Crnkovic, Hilty, Leydesdorff, and Logan; UTI Research Group: José María Díaz Nafría, Peter Fleissner, Francisco Salto, and Rainer Zimmermann, as well as Hofkirchner, and Burgin again; FIS 2010 advisory board: Søren Brier, John Collier, Charles Ess, Pedro Marijuán, Michel Petitjean, and Tom Ziemke, as well as Díaz Nafría, Fleissner, Hofkirchner, Logan, Zimmermann, and Burgin once again; see http://www.triple-c.at/index.php/tripleC/about/editorialTeam

here, but a flavor of the kinds of results that we might obtain from such a study can be given by an examination of the two WIIs in our list that have been produced by members of the newly emergent group.

7.6.1 Logan (2012)

Robert K. Logan is a media ecologist, a former collaborator with Marshall McLuhan, an emeritus professor of physics at the University of Toronto, and a central figure in the *Information–TripleC*–UTI–FIS group.[27] His very recent WII (Logan 2012), published in the journal *Information*, is a relatively informal review that critiques the applicability of the Shannon conception to bioinformatics. In the course of doing so, he provides distinctive answers to two versions of the "What is information?" question that have been much discussed down the years and across the disciplines: 1. What kinds of information are there? 2. What sort of thing is information?

What Kinds of Information Are There?

Much like the authors of other review articles, Logan advocates for a pluralistic approach to conceptions of information. He reviews various conceptions, and argues that each individual conception is appropriate only for a different limited context. He pays greatest attention to four kinds of information, three explicitly (Shannon information, structural information, and biotic information) and one slightly less so, in that he does not label it other than as a Wienerian variant of Shannon information.

(a) *Shannon information*. Logan (2012) asserts that, despite the claims made for the other kinds of information he identifies, it is Shannon information that "has been accepted as the canonical definition of information by all except for a small band of critics" (p. 75). (This may be true for Logan's own discipline of physics but is not obviously so in LIS, for example, nor in philosophy—notwithstanding Logan's accompanying claim that, "[i]f ever pressed on the issue, most contemporary IT experts or philosophers will revert back to Shannon's definition of information" (p. 80).) Logan presents his paper as a timely antidote to what he sees as an uncritical acceptance of the Shannonian paradigm, in which he demonstrates the inapplicability of Shannon information beyond telecommunications engineering, and in particular to bioinformatics.

(b) *Wiener information*. The motivation for Logan's presentation of the Wienerian variant of Shannon information is his conviction that, whatever else information is, it is not entropy. Like "many physicists before" him, Logan (2012) is

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[27] As previously indicated, Logan is a member of the editorial boards of both journals, and was on the advisory board for FIS 2010. Logan is also on the board of directors of the Science of Information Institute (SoII; see Sect. 7.6.2 below).

concerned to demonstrate that "information and entropy are opposites and not parallel as suggested by Shannon" (p. 69). In the published version of Logan's paper, the negative sign (as well as the summation symbol) is unfortunately dropped from the quotation of Shannon's formula for entropy (from Shannon 1948), which thus appears as $H = p_i \log p_i$ (Logan 2012, 71) rather than as $H = -\sum p_i \log p_i$. In any other context, the typographical error would be trivial, but in this particular case, it serves only to muddy the waters of Logan's ensuing discussion of the relationship between information and entropy, where he highlights the "difference in sign" between Shannon's formula and Boltzmann's ($S = k \ln W$, where, as we saw in Sect. 7.5 above, W is the number of different ways of arranging the components of a system while producing the same temperature, and k is the Boltzmann constant). The confusion is compounded by Logan's assertion, in the context of showing how Shannon equates information and entropy, that "Shannon uses a positive sign" (p. 73). Logan's comments about the formulae's signs are misleading for two reasons: (a) Shannon's formula for entropy does not, in fact, use a positive sign; and (b) Shannon's and Boltzmann's formulae are usually considered to be analogous.

The real issue, which Logan does go on to raise, is not that Shannon is somehow mistaken in his representation of entropy, but rather that we would be mistaken if we were to use Shannon's entropy formula to measure information. Logan's position is that, to the extent that information is conceivable as a quantity, it is one that is *inversely* (rather than directly) proportional to entropy. In this sense, Logan's conception is analogous to Stonier's (1986), discussed above in Sect. 7.5.2. Whereas entropy is a measure of disorder, information (for Logan) is a measure of order. Logan (2012) credits Norbert Wiener as the source of this insight: "Just as the amount of information in a system is a measure of its degree of organization, so the entropy of a system is a measure of its degree of disorganization." (p. 86, quoting Wiener 1948). The Wienerian conception of information which Logan advocates is one according to which information is maximized in the case of a maximally *ordered* or organized system, rather than (as Logan interprets Shannon as suggesting) in the case of a maximally disordered, disorganized, randomized, or chaotic system.

(c) *Structural information*. Following Hayles, Logan identifies Donald MacKay as the originator in 1951 of a rival conception of information—"structural information," defined as the "change in a receiver's mind-set" (Logan 2012: 74; quoting Hayles 1999). For Logan, structural information is "concerned with the effect … of the information on the mind of the receiver …" and essentially with meaning—not just "the literal meaning of a sentence," but also the meaning "that the speaker or writer intended," and "the possible interpretations of the receiver" (p. 76).

(d) *Biotic information*. Logan (2012) then turns his attention to conceptions of information applicable in biological contexts, and presents an account of (what he and his colleagues have called) biotic or instructional information, defined as "the organization of [the] exchange of energy and matter" that living organisms (i.e., biotic agents) "propagate" through replication (pp. 78–79) and as the "constraints or boundary conditions" that "partially direct or cause" the processes by which energy is turned into work and by which living organisms reproduce (p. 79).

What Kind of Thing Is Information?

(a) *Shannon information*. At the same time as he characterizes Shannon information as a "measure of the degree of uncertainty for a receiver," Logan (2012) states that Shannon "defined" information as "a message sent by a sender to a receiver" (p. 71), and refers to Shannon's "suggest[ion]" that "information in the form of a message often contains meaning" (p. 74). Set in the context of Logan's goal to distinguish between one conception of information (Shannon's) in which meaning is ignored and another conception (MacKay's) in which meaning is central, the reference to information-as-message is understandable. It should be appreciated, nevertheless, that information-as-message is a conception that is ontologically quite different from Shannon's. On a stricter reading of Shannon's work, neither the semantic content of a message (i.e., its meaning) *nor its form* (i.e., the signals that comprise it) is to be treated as its information: rather, information is that which is measured by Shannon's formula—viz the informativeness, or reduction in uncertainty, produced by a message.

This latter reading is consistent with Hayles' assessment, of which Logan writes approvingly, that "although [Shannon] information is … instantiated in material things, [it] is not itself material" (Logan 2012: 81), but rather is "a quantity" (p. 81), "a pattern" (p. 81, quoting Hayles 1999), and "an abstraction" (p. 82). The idea here is that, ontologically speaking, instances of Shannon information are to be regarded as properties of material things—i.e., in Lowe's (2006) terms, as modes. For Logan, it is precisely this immateriality or insubstantiality of Shannon information that weighs most heavily against its applicability in biological contexts.

(b) *Structural information*. Are we to think of structural information in a Shannonian way, i.e., as a measure of the *amount* of change occurring in a recipient's state of knowledge as a result of receiving a message? Or as the semantic content or meaning of the message, or even as the message itself—the *cause* of, or catalyst for, the change? When he initially introduces the idea of structural information, Logan (2012) is ambiguous on this point; but, a little further on in his paper, he cites approvingly a version of the DIKW (Document–Information–Knowledge–Wisdom) pyramid[28] in which data is defined as "pure and simple facts without any particular structure or organization …," and information as "structured data, which adds more meaning to the data …" (p. 83, quoting Logan and Stokes 2004). Here Logan clearly equates data with "the signals transmitted between Shannon's sender and receiver" (p. 83), and

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[28] See, e.g., Frické (2009).

information with “data ... that ... has meaning” (p. 83). On this account, the intention seems to be that information and meaning are to be treated as things of different ontological kinds: i.e., that meaning (a property) is something that may be ascribed to information (a substance). This conception of instances of information as (in Lowe’s (2006) terms) concrete objects that *have* meaning stands in contrast to those in the semiotic family (e.g., Lagache’s (1997), discussed in Sect. 7.5.3 above) in which information *is* meaning.

(c) *Biotic information*. One way in which Logan’s conception of biotic information is similar to his conception of structural information is in virtue of the distinction that he makes between biotic information itself, and the meaning or effect that biotic information has. Furthermore, Logan (2012) is even clearer about the materiality of biotic information than he is about the materiality of structural information: “biotic information is very much tied to its material instantiation in the nucleic acids and proteins of which it is composed” (p. 84), he writes, adding, “[a] biological system is both an information pattern and a material object or more accurately information patterns instantiated in a material presence” (p. 84). Indeed, it is the material nature of nucleic acids and proteins that allows them to participate in chemical interactions with other biomolecules. Logan contrasts the *symbolic* nature of Shannon information (and, by implication, of structural information) with the *chemical* nature of biotic information: in the former case, the medium of the message, the message itself, and the message’s content (i.e., its information) are all “quite separate” and “independent” of one another, whereas in the latter case, “[t]he medium is both the message and the content” (p. 85).

However, Logan stops short of arguing, as some other physicists and proponents of artificial life have done, that organic matter itself can be reduced to information—that human beings, for instance, are ultimately constructed of information and nothing else. The “mistake” that these others make, according to Logan (2012), is to fail to appreciate what Bateson (1972) and others have clearly articulated—i.e., that the true nature of information is “the *organization* of the molecules of which we are composed” (p. 87, emphasis added) rather than those molecules themselves. Logan seems to be asking us to conceive of information simultaneously as material (i.e., as biomolecular matter) and immaterial (i.e., as some sort of property of that matter). Yet it remains unclear precisely what kind of middle ground is ontologically available to us between (as Lowe (2006) would have it) information-as-object and information-as-mode, or precisely how Logan’s conception relates to Stonier’s (1986) or Bates’ (2005, 2006) versions of information-as-organization.

7.6.2 Díaz Nafría (2010)

We turn now to another author whose institutional connections place him at the center of the *Information–TripleC*–UTI–FIS group identified earlier. José María

Díaz Nafría is a computer scientist and philosopher of science affiliated with the University of Léon, Spain, and the Hochschule München, Germany, as well as the UTI Research Group,[29] the Science of Information Institute (SoII),[30] the International Society for Information Studies (ISIS),[31] and BITrum.[32]

Díaz Nafría's (2010) WII is another review article, but he takes a somewhat more systematic approach than Logan, classifying conceptions of information on three separate dimensions: (1) degree of objectivity of information; (2) type of property emphasized; and (3) disciplinary source.

Objective–Relational–Subjective

The first of these dimensions is defined by a distinction between objectivity and subjectivity: "If it is objective it will be independent from mental states or user's intentions; if it is subjective it will depend on the interpretation of a cognitive or intentional agent" (Díaz Nafría 2010: 82). Díaz Nafría does not make it wholly clear what "it" refers to in this formulation, nor which (if any) of the following manifestations of the objective/subjective distinction he means to prioritize:

- information as a physical, material, concrete substance vs. information as an abstract property;
- information as a naturally occurring phenomenon whose existence as information is not (or not necessarily) the result of human creative activity vs. information as human artifact;
- information as a natural kind whose identity as information does not depend on its being identified as such in the course of human activity vs. information as a social construct; and

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[29] See Sect. 7.6 above. Díaz Nafría is also a member of the editorial board of *TripleC*, and served on the advisory board for FIS 2010.

[30] The Science of Information Institute, founded in 2006, is "devoted to the development and recognition of information as a unique science that crosses traditional scholarly disciplines"; see http://www.soii.info/. Hofkirchner, Logan, and Díaz Nafría are among the members of its board of directors; Burgin, Collier, Dodig-Crnkovic, Marijuán, Salto, and Zimmermann, as well as Brier, Floridi, Elizabeth Buchanan (Center for Applied Ethics, Wisconsin-Stout), and Leah Lievrouw (Information Studies, UCLA), are among the members of its science advisory committee.

[31] The International Society for Information Studies was founded in 2011 with headquarters in Vienna, Austria, and has the aim of advancing "global and collaborative studies in the sciences of information, information technology and information society as a field in its own right by boosting the elaboration of common conceptual frameworks, the implementation of which in practice contributes to mastering the challenges of the information age"; see http://mod1.syros.aegean.gr/soii/index.php/en/news/3-newsflash/41-the-fifth-congress-on-the-foundations-of-information-science-will-be-held-next-summer-in-russia-under-isis-support

[32] BITrum is an "interdisciplinary research group ... constituted to develop a conceptual and theoretical clarification of information, intending to gather all the relevant points of view and pursuing to preserve all the interests at stake (scientific, technical and social)"; see http://en.bitrum.unileon.es/. BITrum was founded by Díaz Nafría and Salto in 2008, and counts Brier, Buchanan, Burgin, Capurro, Dodig-Crnkovic, Fleissner, Floridi, Hofkirchner, Petitjean, and Zimmermann among the members of its scientific committee.

- information as a class of objects whose meanings are intrinsic and do not depend on human decision-making vs. information whose meanings are determined by interpreters.

The upshot is a taxonomy of information theories arrayed from the "most extreme" objectivist category (which includes, for example, Stonier's theory of information as a fundamental physical entity on a par with matter and energy; p. 82) to the most subjectivist (i.e., theories in which properties such as relevance and truthfulness are treated as identity conditions for information; Díaz Nafría places theories of semantic information such as Dretske's (1981) towards this pole).

Syntactical–Semantic–Pragmatic

Díaz Nafría (2010) argues that it is useful separately to categorize information theories on a second dimension according to the kind of "major questions" about the properties of information that they address, and identifies three such kinds:

- questions about the *syntactical* content of information—e.g., "How is it expressed?" (p. 84)—where "messages that … [comply] with all syntactic requirements" are treated as informative to some extent, even if "false, incorrect, useless, [or] redundant" (p. 81);
- questions about the *semantic* content of information—e.g., "What does it represent?" and "With what truth value?" (p. 84)—"whereby the signals or symbols considered by the MTC [Shannon's mathematical theory of communication] are necessarily referred to something" (p. 81); and
- questions about the *pragmatic* content of information—e.g., "What value and utility has it?" (p. 84)—"whereby information is the foundation for action, whether by intentional actors, living beings or automatic systems" (p. 81).

Shannon's theory, for example, is located at the syntactical end of the spectrum, to be distinguished from the various probabilistic conceptions of information that have been provided by philosophers (e.g., Dretske 1981) concerned with measuring the semantic value of propositions. With regard to theories concerned with pragmatics, Díaz Nafría (2010) draws upon sources from anthropology and philosophy. It is notable that, despite the importance of the role played in pragmatics of conceptions of relevance, "truth, value, innovation, [and] surprise" (p. 81), and of the relationship of information to knowledge, he makes no reference to the LIS literature on these topics.

Technical Disciplines–Sciences–Philosophy

Díaz Nafría's third dimension is disciplinary source. Here librarianship is listed (along with automation, telecommunications, and computing) as one of the technical disciplines acting as sources of information theories, but is the only one of the disciplines in Díaz Nafría's taxonomy not to be associated with a named theory.

Díaz Nafría (2010) notes a broad correlation between all three of his dimensions: "the fact of having natural sciences on the left [of the diagrammatic display of the disciplinary taxonomy] and social or human sciences on the right has the consequence that on the left the most syntactical and objectivist theories prevail, while on the right, the semantic, pragmatic and most subjectivist theories are predominant" (p. 88).

As many before have done, Díaz Nafría (2010) asks, "Is there a single notion [of information] useful for all disciplines? In other words, might every scientific notion be reduced into a single and fundamental one?" (p. 88). Rather than providing a direct answer, his preference is to point to the fact that "there are some shortcomings in every concept of information with regard to others" (p. 88), and to indicate the most prominent issues on which agreement would have to be reached before any unified theory could hope to attract widespread support. With that latter goal in mind, the second half of his paper comprises a glossary of some of the concepts that are central to this discourse.[33]

The entry on "Library Science and Special Librarianship" in this glossary identifies "two opposing meanings" of the concept of information used in LIS: "(1) the information as an object in documents, and (2) its radical subjectivization, i.e., information as everything 'that can be informative to someone.'" (p. 101). The distinction being made seems to be that between two separate features of instances of information—viz, their ontological status as concrete objects (in Lowe's (2006) terms), and their representational function—both of which are consistent with various versions of a simple view of information as meaningful data (cf., e.g., Logan's (2012) version of the DIKW pyramid) that is not fully integrated into Díaz Nafría's framework. On this view, the two meanings are complementary rather than "opposing."

7.7 Conclusion

Luciano Floridi is currently the most prolific and most widely celebrated scholar working on problems of philosophy and information (cf. Furner 2010: 170–173). In recent years, he has developed a hierarchy of categories of phenomena that includes (i) data; (ii) (semantic) information, a.k.a. (semantic) content—i.e., *meaningful*, well-formed data; and (iii) factual information, a.k.a. "epistemically-oriented" semantic information—i.e., *truthful*, meaningful, well-formed data (see, e.g., Floridi 2003: 42–46). Floridi's "general" definition of information (GDI) specifies three conditions (data-ness, well-formedness, and meaningfulness) that must be satisfied for an x to qualify as an instance of information, while his "specific" definition of information (SDI) adds a fourth (truthfulness). He notes that the general sense

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[33] A continuously updated and collaboratively authored version—the *Glossarium BITri*—is available online at http://glossarium.bitrum.unileon.es/glossary

in which information is understood simply as semantic content is “trivial” (Floridi 2003: 46), and that, in the context of communication, “the most important type of semantic information is *factual information*” (Floridi 2003: 45, emphasis in original). Floridi (2003: 42) asserts that the general definition has nonetheless become the “operational standard” in fields such as LIS.

Why should this be so? For what reasons have scholars working in LIS come to adopt the general definition rather than Floridi’s (or any other) specific definition? Floridi points in the direction of a possible answer with his identification, among a set of “very important” concepts of information that he elects not to consider further, of “*pragmatic information* … [which] includes *useful information*, a key concept in … information management theory, … where characteristics such as relevance, timeliness, updatedness, cost, significance, and so forth are crucial” (Floridi 2003: 57, emphasis in original). This list of values—alternatives, in a way, to truth—serves to remind us that LIS scholars’ conceptions of informativeness and knowledge itself are typically quite different from those traditionally acceptable either to epistemologists or to natural scientists. LIS theorists in the socio-cognitive tradition, for instance, tend to be interested in changes in personal cognitive structures or “images” of the world, in how such changes are produced, and in how personal needs and desires are thus met, rather than in matters of “truth”; and those in the semiotic tradition tend to subscribe to one or other of the subjectivist versions in which the meanings of signs are underdetermined by properties of the signs themselves (cf. Furner 2010: 173–178).

An upshot of what we might take to be the determination of LIS scholars not to get locked into any “special” definition of information is the ontological pluralism of the field. We should not necessarily expect members of the LIS community to supply any fundamentally original possibilities for conceptions of information. As I indicated at the start, that is the job, strictly speaking, of proper ontology, and LIS is not ontology. But perhaps we do have grounds for taking a moment to reflect approvingly on the lack of *a priori* constraints on the ontological commitments expected of the field’s contributors. As the range of options listed in Tables 7.1 and 7.3 is intended to indicate, it seems that we have barely considered many of the ontological possibilities that are open to us. Instead of ruminating on what we might imagine to be the limited extent to which ideas originating in LIS have influenced the wider debate on the nature of information, we may wish to challenge ourselves to specify with precision whatever it might be that is distinctive, and distinctively useful, about LIS-sourced conceptions of information—in other words, to specify what is missing from a literature in which LIS contributions are too often ignored. The use of proper ontology is suggested as a potentially productive means of identifying hitherto-unexplored possibilities.

In “Information studies without information” (Furner 2004), I argued that we don’t really need a separate concept of information to do information studies, because we already have perfectly good concepts of sign, data, meaning, relevance, and so on, that allow us to get the job done. In this paper, I have wanted to draw attention to the fact that, conversely, there are several scholarly communities other than information studies that do require a separate concept of information, but that those communities have good reason to look to information studies for help. Any approach to conceptualizing information that downplays the contributions of LIS—i.e., information without information studies—is needlessly impoverished, not least on account of the range of ontological possibilities that it misses.

Acknowledgments I would like to thank the editors of this volume, Tom Dousa and Fidelia Ibekwe-SanJuan, for their very helpful comments on an earlier draft of this chapter.

References

Atkin, A. 2010. Peirce's theory of signs. In *Stanford encyclopedia of philosophy*, ed. E. Zalta. Stanford: Stanford University. http://plato.stanford.edu/entries/peirce-semiotics/. Accessed 3 Sept 2012.

Bates, M.J. 2005. Information and knowledge: An evolutionary framework for information. *Information Research* 10(4). http://informationr.net/ir/10-4/paper239.html. Accessed 3 Sept 2012.

Bates, M.J. 2006. Fundamental forms of information. *Journal of the American Society for Information Science and Technology* 57(8): 1033–1045.

Bates, M.J. 2010. Information. In *Encyclopedia of library and information sciences*, 3rd ed, ed. M.J. Bates and M.N. Maack, 2347–2360. Boca Raton: CRC Press.

Bateson, G. 1972. *Steps to an ecology of mind: Collected essays in anthropology, psychiatry, evolution, and epistemology*. San Francisco: Chandler.

Briet, S. 1951. *Qu'est-ce que la documentation?* Paris: Éditions Documentaires, Industrielles et Techniques.

Buckland, M.K. 1991. Information as thing. *Journal of the American Society for Information Science* 42(5): 351–360.

Capurro, R. 1978. *Information: Ein Beitrag zur etymologischen und ideengeschichtlichen Begründung des Informationsbegriffs*. Munich: Saur.

Capurro, R., and B. Hjørland. 2003. The concept of information. *Annual Review of Information Science and Technology* 37: 343–411.

Case, D.O. 2012. The concept of information. In *Looking for information: A survey of research on information seeking, needs, and behavior*, 3rd ed, 45–75. Bingley: Emerald.

Cover, T.M., and J.A. Thomas. 1991. *Elements of information theory*. New York: Wiley.

Díaz Nafría, J.M. 2010. What is information? A multidimensional concern. *TripleC: Cognition, Communication, Co-operation* 8(1): 77–108. http://www.triple-c.at/index.php/tripleC/article/view/76. Accessed 1 Aug 2012.

Dretske, F.I. 1981. *Knowledge and the flow of information*. Cambridge, MA: MIT Press.

Floridi, L. 2003. Information. In *The Blackwell guide to the philosophy of computing and information*, ed. L. Floridi, 40–61. Oxford: Blackwell.

French, S., and D. Krause. 2006. The logic of quanta. In *Identity in physics: A historical, philosophical, and formal analysis*, 354–383. Oxford: Oxford University Press.

Frické, M. 2009. The knowledge pyramid: A critique of the DIKW hierarchy. *Journal of Information Science* 35(2): 131–142.

Furner, J. 2004. Information studies without information. *Library Trends* 52(3): 427–446.

Furner, J. 2010. Philosophy and information studies. *Annual Review of Information Science and Technology* 44: 161–200.

Hartley, R.V.L. 1928. Transmission of information. *Bell System Technical Journal* 7: 535–563.

Hayles, N.K. 1999. *How we became posthuman: Virtual bodies in cybernetics, literature, and informatics*. Chicago: University of Chicago Press.

Lagache, A. 1997. What is information? In *Signals and images: Selected papers from the 7th and 8th GIRI meeting, held in Montpellier, France, November 20–21, 1993, and Jerusalem, Israel, December 10–11, 1994*, ed. M. Bastide, 279–292. Dordrecht: Kluwer Academic.

Logan, R.K. 2012. What is information? Why is it relativistic and what is its relationship to materiality, meaning and organization. *Information* 3(1): 68–91. http://www.mdpi.com/2078-2489/3/1/68. Accessed 1 Aug 2012.

Logan, R.K., and L.W. Stokes. 2004. *Collaborate to compete: Driving profitability in the knowledge economy*. Toronto: Wiley.

Loux, M.J. 2002. *Metaphysics: A contemporary introduction*, 2nd ed. London: Routledge.

Lowe, E.J. 2006. *The four-category ontology: A metaphysical foundation for natural science*. Oxford: Oxford University Press.

Lowe, E.J. 2011. The rationality of metaphysics. *Synthese* 178: 99–109.

Pitzer, K.S. 1995. *Thermodynamics*, 3rd ed. New York: McGraw-Hill.

Qvortrup, L. 1993. The controversy over the concept of information: An overview and a selected and annotated bibliography. *Cybernetics & Human Knowing* 1(4): 3–24.

Rapoport, A. 1955. What is information? *Synthese* 9(1): 157–173.

Rowley, J. 1998. What is information? *Information Services and Use* 18(4): 243–254.

Scarrott, G. 1986. The need for a "science" of education [sic]. *Journal of Information Technology* 1(2): 33–38.

Shannon, C.E. 1948. A mathematical theory of communication. *Bell System Technical Journal* 27: 379–423, 623–656.

Stonier, T. 1986. What *is* information? In *Research and development in expert systems, III: Proceedings of expert systems '86: The sixth annual technical conference of the British Computer Society Specialist Group on expert systems, Brighton, 15–18 December 1986*, ed. M. Bramer, 217–230. Cambridge: Cambridge University Press.

Stonier, T. 1990. *Information and the internal structure of the universe: An exploration into information physics*. London: Springer.

Stonier, T. 1992. *Beyond information: The natural history of intelligence*. London: Springer.

Stonier, T. 1997. *Information and meaning: An evolutionary perspective*. London: Springer.

Weaver, W. 1949. Recent contributions to the mathematical theory of communication. In *The mathematical theory of communication*, ed. C.E. Shannon and W. Weaver, 1–28. Urbana: University of Illinois Press.

Wiener, N. 1948. *Cybernetics: Or, control and communication in the animal and the machine*. Paris: Hermann.