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Society and information

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Introduction

In a presentation to the Royal Society of New South Wales on 7 July 2021, I proposed a high-level *view* of society — the information view — in which the individuals are identical information processors that form a society by interacting via the exchange of information (Aslaksen, 2021). A pictorial representation of this view is shown in Fig. 1, and as the view was incorporated and further elaborated in a later publication (Aslaksen, 2023), I will reference that where appropriate.

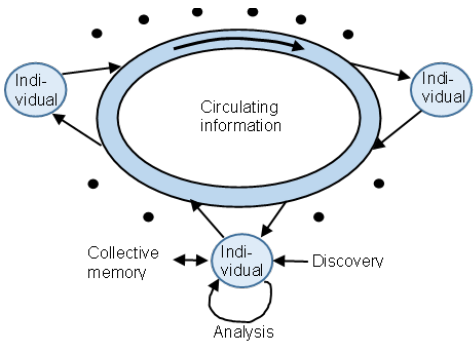

Figure 1: A pictorial representation of our high-level description of society. The circulating information is accessed by and added to by the individuals; discovery is a means for individuals to obtain information from their environment through targeted actions (e.g., measurements), with the interaction with the collective memory sources (archived information) shown separately. Analysis is the creation of new information through processing of information stored in the individual's memory. (Aslaksen 2023)

In the high-level view of society as an information-processing system illustrated in Fig. 1, the individuals are all identical as processors; that is, they have the same ability to process and store information, and their capacity to interact with the circulating information and with the environment is the same, but the content of the information, as opposed to the quantity, is different for each individual. But because they are identical processors, we may consider not the individual-to-individual interaction but introduce the concept of *the individual's interaction with society* in the form of the individual's interaction with a *circulating information*, i.e., the information produced by all the individuals.

However, in my work so far, the key concept of information was not defined; this was avoided by using it as a catch-all for data, knowledge, belief, sentiment, etc. The purpose of this paper is to consider how a more detailed description of information can be developed based on its relation to data and knowledge. The result is not so much a definition of information, in the sense of a statement of what it *is*, as is provided, e.g., in a dictionary, but rather a set of statements about what it must fulfil, whatever it is; requirements on "information" as it is used in the information view of society.

A concept of information

Statement 1: The purpose of information is to enable the transfer of knowledge between persons.

That immediately begs the question: What is knowledge? Knowledge is created by either of two processes. One involves the *observation* of our environment, both natural (including other humans) and created by humans. The observation may employ various instruments and devices, and the observed quantities — the data — may be converted into various physical forms (acoustic, optical, electrical) and be transmitted in any of these forms from the observed object to the observing individual, and via a number of segments, such as an analogue segment (4–20 mA link), a fibre-based digital segment, and a Wi-Fi segment. This is, in our definition, not transmission of information, but of data. Only when the observed data are accessed through our senses and then processed do the observed feature of the environment become part of our *personal knowledge*. For example, when we observe the structure of DNA, we can extract the knowledge that it is a double helix. The observed object does not contain any knowledge, as knowledge is a feature of the human; it requires a knower, but it contains the raw material from which knowledge can be created; in this sense the environment is the *source* of knowledge.

The other process is the processing of personal knowledge stored in memory, i.e., by thinking or what in Fig. 1 is called *analysis*. By recognising relationships between items of knowledge they form a system, and new knowledge may be created as emergent properties of this system. This "second order" personal knowledge is what is generally called *understanding*.

Statement 1 can be compared with a statement in the article (Dienes, 2012): "In my personal opinion, information in HMI studies — in an actual situation, and for somebody — should be understood as data on a carrier, which, if used, modify one's beliefs concerning something," where Dienes uses "belief" where we would use "knowledge."

The processing of data into knowledge depends on the cognitive background of the person; two persons accessing the same data will produce different personal knowledge, with the difference depending on the difference in cognitive background. The cognitive background is basically the knowledge stored in a person's memory.

Statement 2: Information is created in a process by which a person transforms a part of its personal knowledge into the form of a *message* that can be transmitted to another person or persons with the intent that the recipient will be able to extract knowledge from it.

There are several things to note about this statement. One is that, in addition to being created by humans, information is a *social* concept. (In a universe of one individual, there can be data and knowledge, but no information.) The second is that the only difference between information and message is one of quantity; a message is simply an identifiable quantity of information (see below). The third is that the originator may or may not intend the recipient to gain the same knowledge the originator has. In either case, the "packaging" of the knowledge for transmission as information depends on the originator's knowledge of the recipient's

cognitive background. The fourth relates to our view, where transmitting information means including the information in the circulating information — with the intent of making the personal knowledge *public knowledge*. However, as the extraction of knowledge from the information will depend on the cognitive background of the recipient and thus, if the knowledge could be parametrised by a variable, say, q, the knowledge extracted by the members of society from a single item of information placed in the circulating information would be represented by a distribution, $p(q)$. The effect of the collective intelligence — the public discourse — should be to reduce the variance of this distribution, i.e., to produce a consensus. But in practice there are several factors that pervert this ideal operation of the collective intelligence, as detailed in (Aslaksen, 2023).

> **Statement 3**: The knowledge extracted from the information constitutes the information's *meaning* to the recipient.

That is, information has no meaning on its own, the meaning is only revealed once the information is received by a particular person. This is analogous to the information carried by a qubit; it is only revealed once it is measured at the receiver. We could say that the information carries within it all the meanings that can be assigned to it by all intended recipients.

It is interesting to compare the concepts of the three entities — data, information, and knowledge, as well as their relationships, presented here — with those found in the literature. A good source is the article (Zins, 2007), which presents the results of a study involving 44 academics and professionals within Information Sciences. One result was that "many scholars claim that data, information, and knowledge are part of a sequential order. Data are the raw material for information, and information the raw material for knowledge." But not all panel members agreed with this simple sequential order, and Raphael Capurro called it "a fairytale." In our high-level view of society, data is the raw material for personal knowledge, personal knowledge is the raw material for information, and information is the raw material for public knowledge. Information is placed in the circulating, or public, information, from which members of the public can extract knowledge. It follows that while information can be stored in various media, such as print and electronic media, the human mind does not store information. It receives and transmits information, but it stores knowledge.

Also, the article proposes a number of models on the basis of locating data, information, and knowledge in either the universal domain (our public domain) or in the subjective domain (our personal domain), shown in Fig.1 in the article. In our "model," information is the carrier of knowledge between the two domains; the format of this carrier depends on the technology used for transmission.

A structure of information

The high-level view of society as an information-processing system is an *unstructured* view, in that the individuals and their interactions are identical; this is similar to the use of *per capita* quantities in economics. However, within that view we can increase the level of detail in the description, and as a first, small step in that direction consider the following very simple model of a message transmitted between an originator and a recipient, consisting of three components:

1. The data that formed the raw material for the originator's knowledge;
2. the knowledge resulting from the originator's processing of the data; and
3. the additional context the originator believes the recipient will need to extract the knowledge.

The third component of this model makes the distinction between information and message explicit, and it shows that the information is "tailored" to the intended recipient, and we characterise the recipient by introducing the concept of a *role*. An individual can take on a range of roles, in the simplest case restricted to two roles: generalist and specialist. The generalist role is the one we all play every day; it comprises many detailed roles, such as those defined by family relations, by recreational, social, and political activities, hobbies, etc., and presumes a level of education that is average in the society in question. The specialist role is played when persons are engaged in the work for which they are trained, either in a trade or in a profession requiring a significant level of higher education and/or training. These roles comprise numerous more detailed roles associated with particular disciplines. We can note that this division is the same as the one made by Émile Durkheim — between "the political society as a whole and the special milieu for which he is specifically destined" — in Durkheim (1970: 71).

Consequently, the information processed by people falls into two groups: general and special. In reality, some people will spend most, or even all, of their time in the role of generalist, and some people will divide their time between the roles of specialist and generalist. In our view, with its identical individuals, the individual spends a proportion, say h, of its time or effort in the specialist role, and the circulating information can, consequently, be separated into two parts: a special part and a general part.

In the course of the evolution of society, with its steadily increasing specialisation and division of labour, the value of h has been increasing, and the creation of new information has shifted towards the special part of the circulating information. However, some of the knowledge embedded in that information has *implications* for the general part, and so transferring those implications as information to the general part of the circulating information is an increasingly important responsibility for the specialist. Or, in our view, the transfer of information between the two parts of the circulating information becomes an additional and increasing duty for the individual. This activity is indicated in Fig. 2, which also shows the separation of the circulating information into two parts.

Classification of information is not new, but due to our simple general/special division there is mostly only a weak correlation with these other classifications. In his essay *Probleme einer Soziologie des Wissens*, Max Scheler (Scheler, 1924) distinguished between *cultural data* (ideas, beliefs, values) and *real factors* (data about the structure of society). In Karl Mannheim's *Ideologie und Utopie* (Mannheim, 1936) a distinction is made between *exact sciences* and *cultural sciences*, and in Herbert Marcuse's *One-Dimensional Man* (Marcuse, 1964) the second dimension is essentially the processing of general information. The distinction is also expressed in various works on education, such as the *specialised* and *general* components in Émile Durkheim's *Education and*

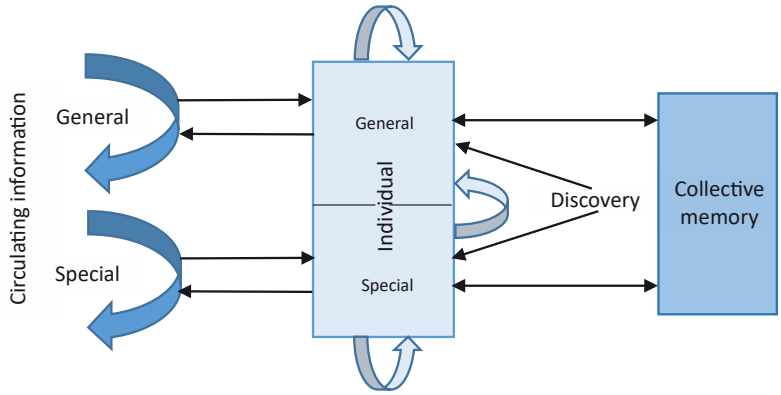

Figure 2: The modification of Fig. 1 to display the two roles of the individual, and the associated splitting of the circulating information into two parts. The three internal flows are flows of knowledge and the Discovery input is a flow of data; all the other flows are information flows.

Sociology (Durkheim, 1970) and in *What is an educational process*, by Richard S. Peters (Peters, 1967), his *principles* correspond approximately to our class 3 information.

With the splitting of the circulating information, the operation of the processing system — the collective intelligence — also displays two somewhat different behaviours. When it is operating on the general part, the behaviour is much as before: with regard to the general information it is a dialectic process aiming at reconciling differences arising between existing and new information and moving the consensus forward in response to changing circumstances — changes driven to a large extent by new applications of technology. It is this process that drives the evolution of society, as detailed in (Aslaksen, 2023). But when it is operating on the special part, it is mainly a matter of fitting the new information into the paradigm of the relevant discipline; such paradigms have, by their nature, a version in the Special domain and a version in the General domain, as e.g., the earth-centric paradigm had a place both in astronomy and in the popular understanding of the universe. Changes to such paradigms — scientific revolutions — are governed by a different process, as described in Kuhn (1962), but the result is a transfer of knowledge from the Special to the General domain, as indicated in Fig. 2.

We would hope and expect that this high level of information exchange, as it becomes increasingly international, would lead to effective cooperation on solving the serious global problems facing us: world war, Quality of Life inequality, global warming, and pandemics. However, here we come up against the difference between being able to do something and actually doing it. To explain this in the current context, we make two further simplifications. The first simplification is a modification of the previous division of the *content* of the information being exchanged into two classes: One, the information related to maintaining our existence, information that we might classify as *facts*. Two, the information related to our view of life, information we might classify as our *beliefs*. The second simplification is to divide the information according to *how it is transmitted*: One, by teaching,

so largely *one-way*, as in education. Two, by interpersonal discussion, i.e., *two-way*, or what on a society-wide basis is identified as the public discourse. The result is a very high-level characterisation of the information exchange in the form of a 2×2 matrix:

	One-way	**Two-way**
Facts	Teaching	Research
Beliefs	Indoctrination	Discourse

If we then represent the strength of the interaction (i.e., the flow of information) by the parameter α and the capability of society to turn the information exchange into action by C, we now have a 2×2 matrix, α_{ij}, with each component showing a different development through history. And, correspondingly, we have four components of capability, C_{ij}, as follows:

- C_{11}: to increase the size of current society, i.e., more of the same.
- C_{12}: to increase our understanding of Nature and our ability to benefit from it.
- C_{21}: to maintain our current beliefs and the current form of society.
- C_{22}: to change our beliefs and transform society.

In terms of this picture, the problem we are facing is that in the great flow of information, and hence in the high value of α, the value of α_{22} is very small and, correspondingly, so is the capability C_{22}. The public discourse has been almost completely supressed by commercial and vested interests, so that instead of a dialectic process we have statements of beliefs and opinions — effectively a form of advertising. This situation was lamented some time ago by Herbert Marcuse in his essay *One-Dimensional Man* (Marcuse, 1964). For the public discourse to function, there needs to be tension in the first place; it only becomes active when the individual perceives a conflict between the social environment in which it is embedded and its own identity. Acceptance of this conflict as a prerequisite to progress is central to Marcuse's critique of modern society. Referencing Hegel, he states that the power of the negative is the principle which governs the development of concepts, and contradiction becomes the distinguishing quality of reason (Marcuse, 1964: 171). And concept is taken to designate the mental representation of something that is understood, comprehended, known as the result of a process of reflection (Marcuse, 1964: 105). It is this dialectical mode of thought that Marcuse calls *negative thinking*. Negative thinking is the driver of Marcuse's second dimension of the development of society; the driver of the first dimension — *positive thinking* — is the acceptance of the perceived world as the basis for reason. The difference between the two modes of thinking is reflected in the difference between "is" and "ought" (Marcuse, 1964: 132).

Some further thoughts

The application of our definition will raise several issues relating to the existing information and social science literature, some of which can already be anticipated. Foremost might be the lack of reference to the work of Claude Shannon (Shannon, 1948). The reason is simple: Shannon's theory is about the communication between a source, S, and a destination, D, both of which are represented by a set of states: $S = (s_1, s_2, \ldots, s_n)$ and $D = (d_1, d_2, \ldots, d_m)$. With each of these sets is associated a probability distribution, such that $p(s_i)$ is the probability of occurrence of

s_i, and correspondingly for $p(d_i)$. The quantity $-\log_2 p(s_i)$ is *defined* as the information generated by the source S by the occurrence of s_i. Correspondingly, the quantity $-\log_2 p(d_i)$ is *defined* as the information received by the destination D by the occurrence of d_i. The averages over the distributions are defined as the information produced by the source and received by the destination, respectively, and are called the *entropy* of the source and of the destination.

This is a completely abstract and axiomatic definition of information with no semantic content, as was emphasised by Shannon; its significance and application lie in being the foundation of a theory that is the cornerstone of modern communications engineering. It is clearly a very different use of "information" as compared with our use, as set out above, and there are many other interpretations of the concept, arising both before and after Shannon's article. A number of these interpretations are discussed in the article *What is Shannon information?* (Lombardi et al., 2014). One issue that arises is whether information is an abstract noun or a measurable entity, with it the assertion that, if an abstract noun, it does not serve to refer to a material thing or substance and cannot be a referring term. To this the authors bring the example of energy, which can be viewed as an abstract noun, but which at the same time refers to a large number of physical characteristics, each with its own unit of measure. There is

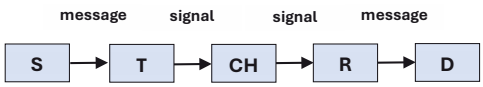

Figure 3: Shannon's model of communications. S = source, T = transmitter (encoder), CH = transmission channel, R = receiver (decoder), D = destination.

no reason why information cannot be similarly defined in several contexts, of which Shannon's theory of communications is one, and our view of society as an information-processing system another.

The issue here is that Shannon's theory of communication is concerned only with the transmission external to the persons involved in the communication; it treats humans as machines, which is why the theory works equally well for communication between humans (transmitting knowledge) as for communication between machines (transmitting data). Shannon's concept of information recognises neither data nor knowledge and makes no distinction between the two: what is being transmitted (the messages) is simply sequences of abstract symbols. In the article (Korogodin & Fajszi, 1986), the authors make a distinction between "information tare" and "information," with the former representing Shannon's information and the latter being something like the meaning of the information. But this still does not reflect the essential role of the individual. For the interaction between persons, Shannon's standard diagram of communication, in Fig. 3, needs to be expanded by including the human part of the process taking place within the Source and the Destination, as shown in Fig. 4.

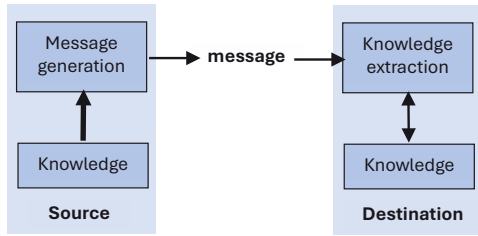

Figure 4: Elaboration of Source and Destination to represent persons and to show the transfer of knowledge.

In Fig. 4, the heavy arrow between Knowledge and Message generation in the Source signifies that this transfer of knowledge is a process reflecting an intention on the part of the Source regarding the knowledge to be received at the Destination — a process driven by the person's *will*. The double-headed arrow at the destination signifies that the extraction of knowledge from the message is a process of *evaluation*, described in some detail in Aslaksen (2023), so that the extracted knowledge depends on the person's existing knowledge.

The issue of the difference between how the concept of information is treated in information technology and in sociology becomes particularly visible when we address the question of how to measure information, and it is an issue that reflects the basic difference between the physical and social sciences. If the subject matter of this essay had been physics, one of the central concepts would be that of energy and on introducing it, e.g., in the form of mechanical work — force multiplied by distance — we would give its measure in terms of basic units — $kg \times m^2 \times s^2$, or joule. Information technology is situated within the physical sciences, and the unit of information is the *bit*. The information transmitted over a channel in a given amount of time is simply the number of bits transmitted. But that this measure has little to do with our concept of information is demonstrated by considering an item of information being transmitted repeatedly; the number of bits transmitted increases in proportion to time, whereas the information transmitted remains fixed.

In closing, it is important to realise that our item of information remains an intuitive concept and cannot be measured in terms of any physical quantity. But the statement "what cannot be measured does not exist" is too simplistic when dealing with human concepts and thought processes, and the little diversion into Shannon's theory of data transmission was intended to demonstrate the complexity added when source and destination are replaced by humans. Examples of an analogous increase in complexity are: going from integers to real numbers; from bits to qubits; and from robots to humans. This does not mean that the simplified concept is not useful — on the contrary, simplification may increase the usefulness, but it should not be a limitation on our quest for understanding.

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