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Codeless Communication and the Shannon-Weaver Model

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Abstract. Communication models based on the Shannon-Weaver communication model are the most commonly used, but efforts to transcend this model in other domains such as human communication are increasingly common. The semantic aspect of information remains an unsolved problem. This paper concentrates on a specific feature of the model: "communication" between source and transmitter. This dimension of the model, which we call codeless communication, is important because it is not based on pure communication considerations in regard to coding or on characteristics of the channel. The issue is how the source creates the information that is coded to enter the communication system. In this paper, elements in the world are conceptualized as flow systems that continuously reveal data to no specific recipient. The resultant flow-based representation is applied uniformly to source, transmitter, channel, recipient, and destination.

Keywords: Shannon-Weaver model, information, communication, flow

1. Introduction

After providing a mathematical definition for information and communication, Shannon [6] states, "the fundamental problem of communication is that of reproducing a message sent from one point, either exactly or approximately, to another point." Communication models based on the Shannon-Weaver communication model [8] are the most commonly used. "Within a decade a host of other disciplines—many in the behavioral sciences—adapted it to countless interpersonal situations, often distorting it or making exaggerated claims for its use" [7].

The difficulty with the Shannon-Weaver model is its complete detachment of information from semantics. The far-reaching impact of this model's definition of information and communication has persisted as the reason for conceptual difficulties in information systems. According to Firestone [14],

Efforts to transcend Shannon information are increasingly common... Some of the new efforts apply the notion of statistical complexity... Others focus on the idea of 'likelihood'... Still others develop entirely new alternative measures and theories, ... It is no exaggeration to say that Information Theory is exploding today, ... But, it is also true that this explosion has not yet reduced the interpretive, semantic aspect of information to a formal or physical model... Thus the analysis and measurement of information still remains unconquered territory.

Fig. 1 shows the classic schematic diagram of the Shannon-Weaver model of communication. It includes the basic elements of a communication system: source, sender, message, channel, receiver, destination, and noise source. It ignores "the question of data, of how a given repertoire of symbols—a pre-selected collection of states—gets itself registered with an agent as a *data set* from which information can then be extracted" [9]. Firestone [14] states,

. . . application [of Shannon's measure of information] requires the specification of selection probabilities of all documents in a finite and supposedly complete comparison set, conditions which cannot be realistically fulfilled in many situations. Also, it doesn't speak to other contexts for measuring information that we may construct.

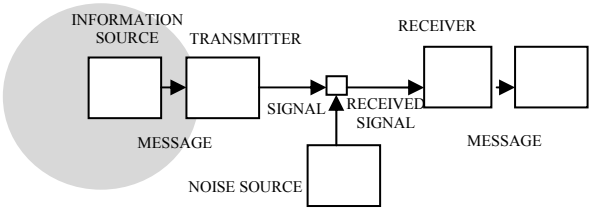

Fig. 1: Schematic diagram of the Shannon-Weaver model

This paper examines this specific aspect of the "communication" between the *source* and the *transmitter* and the origin of information supplied by the source (shaded circle in Fig. 1). This dimension of the model is important because it is not based on pure communication considerations that focus on coding or on characteristics of the channel; hence, we call it codeless communication. Most information comes into the communication *core* of the model (transmitter-channel-receiver) through the source. The issue is how the source *acquires* this information (e.g., head or tail in a coin toss) that is coded to enter the communication system.

Clearing the semantics of methods of extracting information would contribute to developing a general communication model. Yet, better, this paper introduces a *uniform* method of conceptually representing different stages of communication.

2. Motivational Example

Shannon defines information to be proportional to uncertainty. A high level of uncertainty is associated with a high amount of information. A low level of uncertainty is associated with a low amount of information.

Information is a measure of one's freedom of choice in selecting a message. The greater this freedom of choice, the greater the information, the greater is the uncertainty that the message actually selected is some particular one. Greater freedom of choice, greater uncertainty, [and] greater information go hand in hand. [8]

According to Kauffman [10],

He [Shannon] does not really tell us what information IS. Any such meaning is buried in the idea of a minimal "choice". By who or what? How? With respect to what feature of what is the choice made? What is the consequence in the real world of making the choice? How is that consequence achieved?

Consider the following example given by Sveiby [11]:

Let us assume a natural system or object like a stone. The stone is meaningless in itself. Even a stone can thus be seen as "containing" an infinite number of potential meanings. It is a very large amount of "information" in Shannon`s sense. … We will also see that the "sender" of the signals is not the stone but the human being`s apparatus. …The object-called-stone exists as a source of potential information, which is not there until some human being interprets it, i.e. gives it meaning.

The striking feature in such a description is that *something* has flowed from the stone to the person (source), yet any communication, as typically understood through the channel, starts only after the person sends this information to the transmitter. Does this mean that the flow of this *something* from stone to source to transmitter is not part of the communication system? Or is this situation, which involves transfer of something to the source, another type of process? It is not possible that the stone is the source, because, according to Sveiby's description, "the 'sender' of the signals is not the stone." Note that if there were no stone, the *something* in this example would never exist, let alone communicate. In a general communication system, the *origin* of information is, somehow, in the stone. It may be called data; nevertheless, it has its own transfer mechanism (communication) that is ignored in the example.

We can observe that there are two systems:

1. Communication that involves transmitter and recipient
2. A process of transfer that does not involve explicit *sender* (stone) and is not related to the uncertainty notion on which the Shannon-Weaver model is based.

The absence of the notion of uncertainty has been explained by many workers in the area. For example, Marshall [12] notes that

We can mathematically assign a value to how successful the decoding is.... We can also make it with respect to DNA or Bee waggles. But we cannot make it with respect to gravity, or magma flows, because with these systems there is no decoding of a pre-determined message. The “message” we get from magma flows is always 100% “correct” because it only represents itself. This is in stark contrast to DNA or Bee waggles, where there clearly is a pre-determined message. Thus we see a vast chasm between coded systems and naturally occurring systems. Codes do not occur naturally.

Thus, contrary to Sveiby’s claim, the stone in our example sends “messages”!

If we conceptualize the “something” received from the stone as data, then according to Callaos and Callaos [13],

"Information," as "meaningful data," would be defined as "significant data", "data full of meaning", "data having a meaning or purpose," and as "data plus meaning" would be defined as "data plus significance," "data plus the thing conveyed by it in the mind."

The important point here is that some type of *communication process* exists between the stone and the source. Note that the source in this type of phenomenon is not necessarily a human being; for example, the expansion of *mercury* (response to atmospheric temperature) in a thermostat may be detected by a *computer*. Like the stone, the mercury in this case is the origin of data received by the computer.

There is another way to accommodate *uncertainty* in the stone example. We can say that the observer is uncertain about features of the stone; by receiving (perceiving) *something* from the stone, the observer then becomes certain. Nevertheless, since our main concern is *communication*, who sends to whom? Is the stone sent to the observer, or the observer sent to him or herself?

The most basic example of the Shannon-Weaver model is a coin-toss. Clearly, the *event* of the “coin landing” plays the role of the stone in the previous example. This event transfers *something* (head or tail) to the person tossing the coin. The person is clearly uncertain about the event before the toss. This uncertainty is eliminated after the coin is tossed, but since our main concern is communication, again, who communicates with whom? Is the person *informing* him or herself?

We can conclude that a general communication system such as the Shannon-Weaver model includes two types of communication processes: a codeless-based, and a sender-recipient–based communication system. Such a conceptualization would contribute to the clarification of several issues related to semantics in communication science.

In the next section, to make the paper self-contained, I describe a conceptual representation that will be adopted in the rest of the paper. The basic ideas have been previously presented in many publications (see [1-5]).

3. Flowthing Model

The Flowthing Model (FM) represents communication on the basis of two fundamental notions:

1. A *flow* that represents the conceptual movement of flowthings
2. A *triggering* that represents the start of a new thing, e.g., another flow, an operation

Flowthings are things that can be transferred, released, and created, arrive, be accepted, and be processed by flow systems (*flowsystems*), including “things” such as data, information, knowledge, signals, and so forth. In the context of communication, flowthings are things that are being communicated. The stages of the flowsystem comprise Creation, Release, Transfer, Arrival, Acceptance, and Processing. A complete flowsystem is shown in Fig. 2. The environment of the flowsystem is called its *sphere*. For example, in the sphere of a retailer, we can observe the flowsystems of orders, information, invoices, and even physical items. In the context of communication, spheres correspond to the communicating agents. In Fig. 2, we can assume that arriving flowthings are always accepted. In this case, the stages Arrive and Accept can be represented by a single stage called *Receive*.

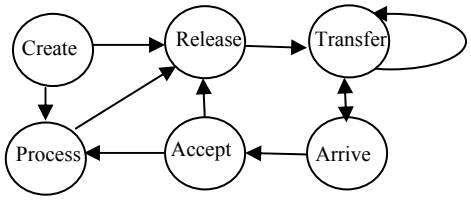

Fig. 2: Flowsystem, assuming that no released flowthing is returned

The logical sequence of different stages is important. Any flowthing (e.g., e-mail) cannot be *transferre*d before being *released*. A flowthing can be released without being transferred, as in the situation of a failure in the channel; thus, released flowthings are queued, waiting for the channel to be fixed. Clearly, a released flowthing cannot arrive (e.g., at another sphere) without first being transferred.

The transfer stage represents the input/output component of the flowsystem. It is the interface of the flowsystem with the outside. Suppose we have two spheres: a sender, and a recipient. The sender creates, releases, and transfers messages; in the recipient's sphere, the message is transferred (the recipient's input component), arrives, is accepted, and is processed.

It is possible that a flowthing enters the transfer stage of a sphere, but it never arrives. A byte (string of bits) may actually reach the port (the connection) of a device, but for some reason (a fault between the port and buffer), it fails to arrive at the arrival place (e.g., buffer). A newspaper is "transferred" to a house lawn, but it may never arrive in the hands of the house resident. Nevertheless, upon arrival it may be rejected or accepted. So, a flowthing arrives only after being transferred, and it is processed only after being accepted.

A released, transferred, arrived, accepted, and processed flowthing cannot be in the created state. An already flowing thing cannot be considered a newly created thing.

Example: According to Salthe [15],

In Peircean semiotics ... Signs are representations of contexts erected on the boundary between a semiotic system's internal and external dimensions. For example, words exist external to the user, in the language of a social system, but also have become ―[implanted] in the minds of individuals, where they guide thinking.

Salthe [15] then illustrates "the generation of meaning during Peircean semiosis for living systems." The building of perception is conceptualized as "a developmental process," depicted in Fig. 3.

While Fig. 3 does not fairly reflect Salthe's complete study, it serves our purpose: exemplifying streams of flowthings related to information, data, and signals in a representation resembling a sketch drawn by hand. In contrast, the FM representation reproduces these flowthings in an engineering-like drawing that distinguishes different types of flowthings along with their basic operations and transformations. Fig. 4 shows the resultant diagram according to our understanding of involved flows. The *external object* (e.g., a stone) generates, say, data of its features (e.g., color, texture) that are transferred to the mental sphere. This sphere includes two flowsystems: data and interpretants. The transfer stage (perceptual apparatus) delivers the data that trigger creation of interpretants, in turn triggering creation of signs.

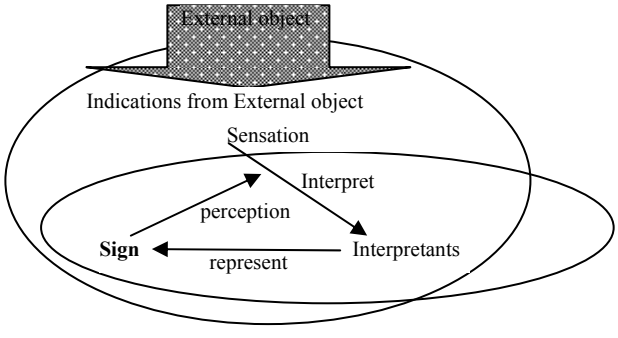

Fig. 3: The generation of meaning during Peircean semiosis for living systems (partial from [15])

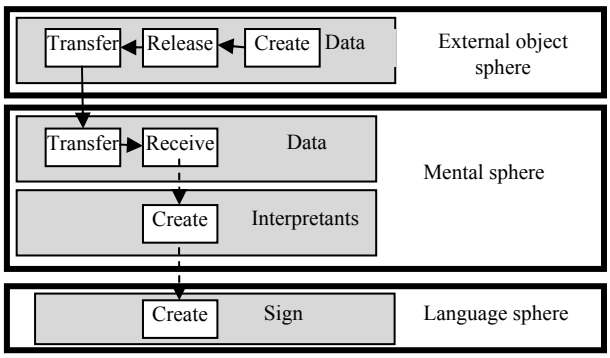

Fig. 4: FM-based representation of the diagram in Fig. 3.

4. FM-based Conceptual Description

FM can be utilized in modeling communication that includes code- and codeless-based systems. It can be applied to a variety of models; however, we concentrate here on enhancing the original diagram of the Shannon-Weaver model given in Fig. 1. Fig. 5 shows the resulting diagram with an attempt to preserve most of the terms of the model. In order to focus on our purpose of developing a better semantics of the Shannon-Weaver model, we use the neutral terms *source* and *destination* flowthings. Using such terms as *data* and *message* might blur the issue under consideration. So, the source can be a human observer of an external object (e.g., a stone), or an event (a coin-toss) that "supplies" flowthings to the transmitter. It is possible to consider the external object or event as the source and the human being as simultaneously observer and transmitter. The origin of the flowthing can be a codeless source, as in the example of the stone, or a communicator that supplies the transmitter with English sentences to be coded and transmitted.

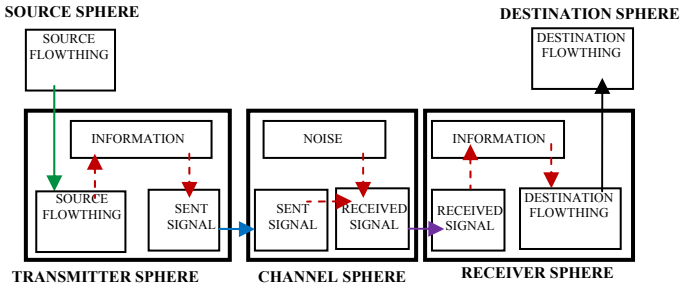

Fig. 5: FM-based diagram of the Shannon-Weaver model

The transmitter comprises a minimum of three flowsystems: one supplied by the source (sourcethings), one constructed to be sent through the channel (signals), and one facilitating the coding between these two flowsystems. We call this third flowthing *information*. In case of the stone example, information is the result of processing of sourcethings (e.g., features of the stone). In the case of English sentences supplied by the source, information is the transmitter processing that constructs the set of "messages" to be mapped to transmitted signals.

This model handles a wide variety of cases involving the relationship between a source and a transmitter. To give an example of an extreme situation, assume that the source and the transmitter are one entity comprising a human being. We can conceptualize the origin of the "message" flowthing as the "knowledge" source of that person, who supplies knowledge flowthings. These knowledge flowthings are supplied to the person him/herself as a transmitter and trigger the creation of information flowthings (e.g., discrete "mental English sentences") that in turn are mapped to, say, telegraph signals to be transmitted.

Notice that there is no attempt here to propose "a new theory of cognition"; rather, we demonstrate that whatever mental sphere is conceptualized, FM provides a systematic tool to map the involved flows resulting from such a conceptualization. FM demands "recognizing flowthings and their flows" in describing any communication system. For example, the philosophy of materialism claims that the only thing that exists is matter (and energy) and even *Mind* is the result of material interactions. This concept can be represented in terms of brainthings, and mindthings that are created and processed, and triggering between them. Brain flowsystems (e.g., neurons) can also include the stages of release, transfer, arrival, and acceptance. The point here is that FM is a systematic tool that can be used to "map" our "semantics."

While the channel in the Shannon-Weaver model is reduced in the representation to a small box, in the FM-based model, it is a fully recognizable sphere, adding uniformity to any representation of a communication system. The source, transmitter, channel, recipient, and destination are spheres with their own flowsystems. The channel has three flowsystems: sent signal, received signal, and noise. Noise and "sent signal" (may) trigger the creation of received signal. Note that the FM description sets up the basic streams of flow that can be supplemented by additional specifications such as constraints, timing, logical operators (e.g., AND, OR, WAIT), and so forth.

Finally, the recipient plays a role that mirror-images that of transmitter, where information is decoded and the "message" sent to the destination.

5. Conceptual Description of Codeless Communication

Utilizing the FM-based model, one can model codeless communication as a special case, as shown in Fig. 6 with the stone example. Stimulus data can be defined as a type of flowthing (datathing) that is created, released, and transferred in a codeless communication system. There is no controversy that such a stimulus is physical. It may trigger the emergence of information, as illustrated in Fig. 6. The stimulus data is the raw input that is received (sensation) and processed to be perceived to trigger mental flowthings.

Data … and the regularities that reside within the data, are properties of events and things "out there" in the world – i.e., physical processes and products – that become available to us as sentient beings through our physiological apparatus, often amplified by instruments and other artefacts. [9]

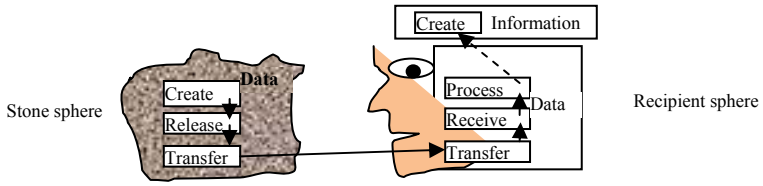

Fig. 6: A stone supplies data in codeless communication

The new aspect in FM is conceptualization of the stone (an element in the world) as a flowsystem that is continuously revealing its data to no specific recipient. To be stimulated by such "freely" transmitted flowthing, the person must have a flowsystem that receives such type of flowthing. An element of the world transmits its features in all directions, analogous to radioactive materials emitting radiation in all directions. If we conceptualize such a radioactive material, our representation would include two flowsystems: physical data (e.g., color, texture) and radiation.

Information is a flowthing that can only be *created* and *processed.* It is not a *transferable flowthing.* Information in one system *refers* to other information in another system through signal flowsystems. It should be noted that the origin of "emergent information" [14] is not necessarily rooted in the interaction with environment.

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