The Information you have but do not Believe

Fred Dretske's *Knowledge and the Flow of Information*

In the beginning there was information. The word came later. The transition was achieved by the development of organisms with the capacity for selectivity exploiting this information in order to survive and perpetuate their kind. [...] Meaning, and the constellation of mental attitudes that exhibit it, are manufactured products. The raw material is information.

Information is out there

As becomes clear from this quote, Dretske understands information as a phenomenon of the world, which exists independently of its actual or potential use by any interpreter.

The counterintuitiveness of this view to some is in Dreteke's words due to a "confusion of information with meaning".

Getting clear about the difference between meaning and information, will enable us to think about information as an "objective commodity, something whose generation, transmission, and reception do do not require or in any way presuppose interpretive processes.

Back to MCT

Dretske starts with reconsidering what was achieved by MCT already.

As we've learned, MCT identifies the amount of information associated with, or generated by, the occurrence of an event with the reduction of uncertainty, the elimination of possibilities, represented by that state of affairs.

When an ensemble of possibilities is thus reduced, the amount of information associated with the result is a function of how many possibilities were eliminated in reaching that result.

Amount vs. Content

MCT gives us a general formula for computing the amount of information generated by the reduction of n (equally likely) possibilities to 1. If s (the source) is some mechanism or process the result of which is the reduction of n equally likely possibilities to 1, and we write I(s) to denote the amount of information associated, or generated by, s, then

$$I(s) = \log n$$

This will give us the amount of information every signal informaing us about s will carry. But it will not give us the informational content of any message, it doesn't discriminate messages in this way.

Average Amount

How we can go on to find a formula for a source producing non-equiprobable results, and how we can determine how much of the information generated at the source is received after transmission, should by now be clear.

MCT, being concerned with engineering problems, deals with the average amount of information produced and transmitted. To set up a communication system it matters most that the system works for the things it is most likely to do. But this will not be of this importance to us.

Noise

We remember that noise can reduce the information received. I(s) is the amount of information generated, I(r) the amount of information generated at the receiver, then $I_s(r)$ is the amount of information received about s at r:

$I_s(r) = I(r)$ - noise
$I_s(r) = I(s)$ - equivocation

Whereas equivocation is the information lost in the communication process, and noise that information added to the transmitted message that is not about s.

Causation

It seems as insofar as the transmisssion of information has been described, it is a process that depends on the causal interrelatedness of source and receiver.

The way one gets a message from s to r is by initiating a sequence of events at s that culminates in a corresponding sequence at r. In abstract terms, "the message is borne from s and r by a causal process which determines what happens at r in terms of what happens at s".

Causation

Although this view is correct insofar as the flow of information may and in most cases does depend on underlying causal processes, nevertheless, the informational relationships between s and r must be distinguished from the system of causal relationships existing between these points.

Causation is certainly not sufficient, since different s-states can cause the same r-state. For Dretske it additionally isn't necessary either (but we won't go into the details here).

Going Further

Now MCT does finally not tell us what information is. It ignores, as we have seen already, all questions having to do with the content of signals, what specific information they carry, in order to describe how much information they carry.

But in doing so it is still interesting for our goal to understand what information is. Since by analyzing how much information a signal carries, MCT imposes constraints on what information a signal can carry, constraints we can use to develop an account of how much information a signal does carry.

Semantic concept? Yes. Meaning? No.

Although Dretske goes on to analyze information as a semantic concept, he warns us not to confuse it with meaning. Not every meaningful message carries information and even if it carries information, this information doesn't have to be identical with its meaning.

Semantic concept? Yes. Meaning? No.

'I'm drunk.' is meaningful, independent of its truth. But this sentence carries information only if it is true what this sentence asserts.

"What information a signal carries is what it is capable of 'telling' us, telling us truly, about another state of affairs. Roughly speaking, information is that commodity of yielding knowledge, and what information a signal carries is what we can learn from it."

Centre for the Study of Logic, Language, and Information

HEINRICH HEINE UNIVERSITÄT DÜSSELDORF

Manuel Bremer, Daniel Cohnitz
Information Flow and Situation Semantics
ESSLLI 2002

No Misinformation!

"False Information" or "Misinformation" are not kinds of information, according to this view!

"Reliable Information" is a redundant way of speaking!

Away from the average amount

As we've said already, MCT is interested in the average amount of information, which we are not. Dretske exploits MCT and gets to the following formulas:

The amount of information generated by a particular event s_a:

$$I(s_a) = \log 1/p(s_a)$$

Away from the average amount

The amount of information carried by a particular signal r_a about s_a:

$$Is(r_a) = I(s_a) - E(r_a)$$

whereas $E(r_a)$ is understood to be the equivocation associated with the particular signal r_a.

Too many possibilities

To apply the formulas to concrete situations seems to involve an estimate of the alternative possibilities. But what are the alternative possibilities to my ... sacrifizing a cat? playing tennis?, eating lunch, ... What are the associated possibilities of all these possibilities? What are the conditional possibilities of each of these given the configuration of photons reaching your visual receptors from a tv-screen showing me sacrificing a cat? We should know all these if we want an absolute measure, a definite numerical figure for the amount of information generated by an event or carried by a signal.

Enough for comparisons

Although we cannot get such an absolute measure, we can use these formulas to make comparisons, in particular comparisons between the amount of information generated by the occurrence of an event and the amount of information a signal carries about that event.

Comparisons and informational content

For informational content we want to know, not how much information is generated by the occurrence of s_a, not how much information r_a carries about the occurrence of this event, but whether r_a carries as much information about s_a as is generated by its occurrence. In order to answer this question, one does not have to know the value of $I(s_a)$ or the value of $I_s(r_a)$. Inspection of

$$Is(r_a) = I(s_a) - E(r_a)$$

shows that all one has to know is whether the equivocation is zero or not. In this case the signal carries as much information as is generated at the source.

Xerox Principle

Given these considerations, we can formulate the famous Xerox-Principle:

> If *A* carries the information that *B*, and *B* carries the information that *C*, then *A* carries the information that *C*.

Xerox Principle

This principle is indeed fundamental for any theory of information flow. Although for information to flow it presupposes that the equivocation will be zero.

Centre for the Study of Logic, Language, and Information

HEINRICH HEINE UNIVERSITÄT DÜSSELDORF

Manuel Bremer, Daniel Cohnitz
Information Flow and Situation Semantics
ESSLLI 2002

A Semantical Theory of Information

Given these consideration we can now state two conditions, information must satisfy:

A Semantical Theory of Information

If a signal carries the information that s is F, it must be the case that

(A) The signal carries as much information about s as would be generated by s's being F.

A Semantical Theory of Information

If a signal carries the information that s is F, it must be the case that

(B) s is F.

A Semantical Theory of Information

(A) and (B) are both necessary but still not jointly sufficient. Suppose s is a red square. s's being red generates 3 bits of information and so does s's being square. Now a signal carrying the information that s is square carries as much information as is generated by s's being red and s is red, but the signal doesn't carry this information.

A Semantical Theory of Information

(C) The quantity of information the signal carries about s is (or includes) that quantity generated by s's being F (and not,say, by s's being G).

A Semantical Theory of Information

(A) is the *communication condition*, (B) and (C) are the *semantic conditions* on information.

Informational Content

Now we are in a position to formulate a definition of the information contained in a signal that simultaneously satisfies these three conditions.

Informational Content

Informational content:

> A signal r carries the information that s is F = The conditional probability of s's being F, given r (and k), is 1 (but given k alone, less than 1).

Whereas k stands for what the receiver already knows about the possibilities that exist at the source.

Informational Content

It makes little sense to speak of *the* informational content a signal carries. For if a signal carries the information that s is F, and s's being F carries the information that s is G, then this same signal carries the information that s is G.

In general, if there is a natural law to the effect that whenever s is F, t is G, then no signal can bear the message that s is F without also conveying the information that s is G.

Nesting relation

We can account for this nested in information by the following definition:

> The information that t is G is nested in s's being F = s's being F carries the information that t is G.

Such nesting can be *analytically* or *nomically*.

Meaning / Information

This feature of information will help again to distinguish the concept of information sharply from it's meaning. 'Joe is at home or at the office' is not part of the meaning of 'Joe is at home' but if a statement carries the information that Joe is at home, it thereby carries the information that Joe is either at home or at the office.