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Information and Context

Some philosophical remarks on the recent discussion of the concept of information in the German Informatics Society

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Introduction (1)

- The discussion in the German Informatics Society are reflections of earlier philosophical discussions of the concept of information ([Janich98], [Ropohl01])
- First reflections dealing with Shannon's concept of information and its ambiguity:
- [Rechenberg03]: "Zum Informationsbegriff der Informationstheorie"
- [Klemm03]: "Ein großes Elend"

Introduction (2)

- A further reflection as an attempt to give a more precise formulation of a semantic oriented concept of information:
- [Endres04]: “Der Informationsbegriff - eine informatikorientierte Annäherung”
- A reflection concerning the reference between the problematical concept of information and the problematical concept of knowledge society:
- [Endres03]: “Die Wissensgesellschaft und ihr Bezug zur Informatik”

The information concept's ambiguity (1)

A point of view ([Rechenberg03], [Klemm03]): In computer science the concept of information has actually two meanings:

- The first meaning is originally Shannon's concept.
- His question [Shannon48]: If you have a communication system with a sender, a receiver and a non disturbed canal, what is a minimal binary code to transfer a text message?
- The answer is proofed for a text with n different characters of a given alphabet A:

The information concept's ambiguity (2)

Shannon's Theorem: A text consists of n different characters a_1, a_2, \dots, a_n with probability p_1, p_2, \dots, p_n to appear in the text, then the minimal number H of bits to code the text is:

$$H = \sum_{i=1}^n p_i * \log_2(1 / p_i)$$

- Shannon called H the “entropy” of the binary coded message.
- The origin of the ambiguity [Shannon48]: “The quantity H has a number of interesting properties which further substantiate it as a reasonable measure of choice or **information**”.

The information concept's ambiguity (3)

- Advantage of Shannon's concept: applications in coding theory, in data compression and in communications engineering
- Lack: Any permutation of the characters a_1, a_2, \dots, a_n leaves H invariant. H is no measure for the content of the transmitted text: Example: The latin letters A, E, H, N, S occur generally in German texts with probabilities p_1, p_2, \dots, p_5 . Therefore: $H('H', 'A', 'N', 'S', 'E') = H('S', 'A', 'H', 'N', 'E')$. But the meaning C of both transmitted texts $m1='HANSE'$, $m2='SAHNE'$ is different: $C(m1) = 'a medieval commercial federation of towns almost in the northern part of Europe'$, $C(m2) = 'cream'$ ($C(m1) \neq C(m2)$).

A syntactic and a semantic concept of information (1)

- Solving the ambiguity: A standard differentiation in informatics between messages/data and information ([Rechenberg03], [Klemm03]):
- Syntactic information is a measure for the shortest coding of a message (Shannon's H). The syntactic information is given by the message itself and can be quantified.
- Semantic information is the meaning of a message for the receiver. It results in the process of interpretation of a message on the side of the receiver. Semantic information "can not be quantified" ([Rechenberg03], p.321, transl. GB.).
- This differentiation is originally set up in linguistics (C.S. Peirce et. al.).

A syntactic and a semantic concept of information (2)

The differentiation between syntactic and semantic information is also inherent in a layered architecture of communication:

layer	transmitted entities	possibly defined by	equivalents in natural languages
informa-tion	(semantic) information	receiver's interpretation (sometimes: agreed interpretation rules between sender and receiver)	meaning of words / sentences
message	messages / data	protocols / data structures	words / sentences
physical	signals (optical, electronic, acoustic, ...)	normalized pulses of the given signal type; methods of modulation	phoneme / graphem

Information and Context (1)

- [Endres04] attempts to give a formalized description of the semantic concept of information: For different interpretations of one message, which are produced by different receivers, he introduced a partial defined mathematical mapping:

$$\begin{aligned} I : Z^* \times K &\rightarrow S \\ (u,k) &\rightarrow s = I(u,k) \end{aligned}$$

- Example: an alphabet $Z = \{a,b,A,B\}$, Z^* is the set of words, which can be produced from Z ([Endres04] reduced in the example Z^* to a finite set, e.g. Z^* is the set of words with a fixed maximum length L , e.g. $L=2$). K is a set of contexts, where each context is identified by a character string: $K = \{k_1, k_2, \dots, k_m, \dots\}$
- Examples of contexts: $k_1 \cong$ German traffic system

Information and Context (2)

- Examples of contexts: $k_2 \cong$ chemistry, $k_3 \cong$ music
- If a message u from Z^* is sent (e.g. $u = "B"$), one has different interpretations u in each context:
- $I("B", k_1) \approx$ the registration number of Berlin.
- $I("B", k_2) \approx$ the symbol of the chemical element Bor.
- $I("B", k_3) \approx$ the symbol for the key B major.
- The mapping I is only partial defined, e.g. for the pair $(“A”, k_3)$ exist no $s = I(u, K_3)$, because no chemical element with marking “A” exists in the periodical system.

Information and Context (3)

Some remarks to [Endres04] :

- There are some problems in the formalization of K: Is a context always a set? If it is a set, a finite or infinite?
- The problem of polysemantical phenomena is well known and well studied in computer linguistics / natural language processing. - These hints are missing.
- The description of contexts is very similar to the attempt of so called semantic primitives in linguistics. Both lead to the problem that word definitions are needed to describe contexts or semantic primitives. - Possibly ontologies can help.

Epilogue

- An open question, which is close related to the semantic concept of information is the reference of this concept to the concept of knowledge. (comp. [Endres03]).

References (1)

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