Seminários Interdisciplinares CLE – Auto-Organização

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CENTRO DE LÓGICA, EPISTEMOLOGIA E HISTÓRIA DA CIÊNCIA

UNICAMP

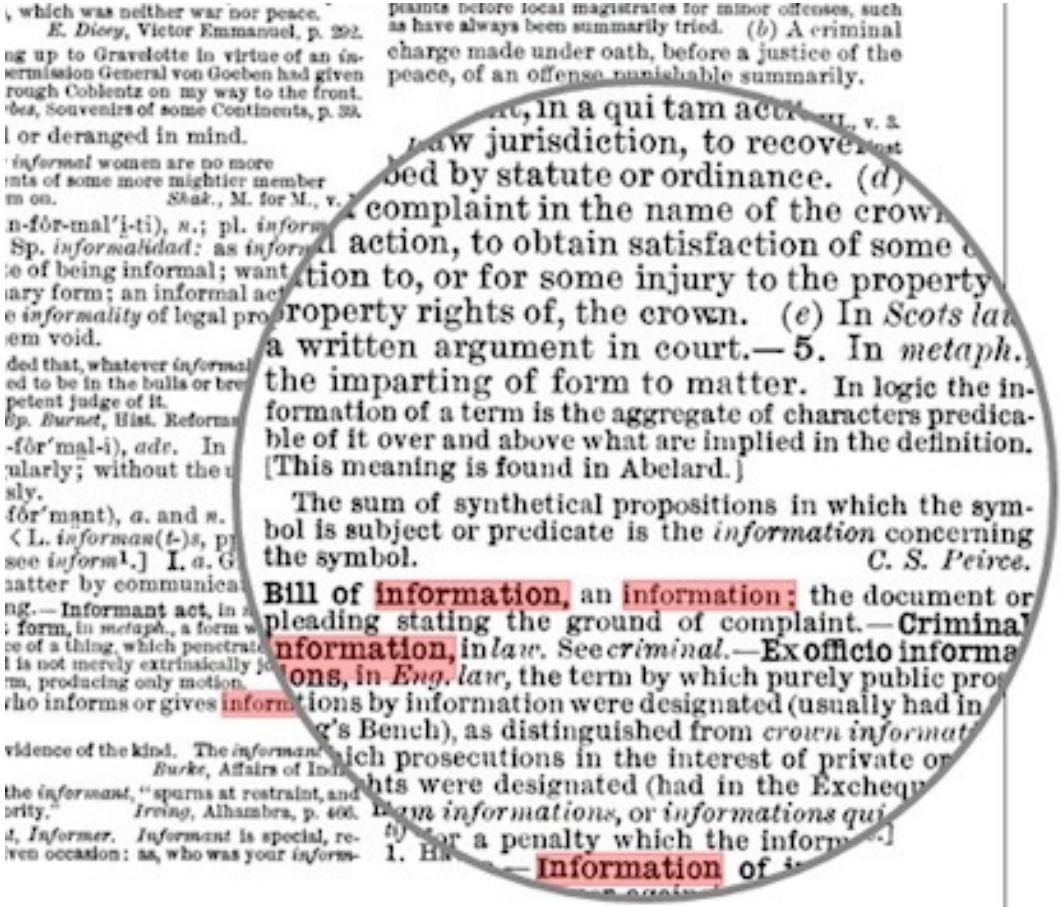
Peirce, the lexicographer

“the one continuous focus of Peirce's intellectual energy was his lexicographic work for the Century Dictionary, which in its first edition ran to 7046 quarto pages. He had begun writing definitions as early as 1883 and he continued with varying degrees of concentration from then on, but his most sustained and intensive effort came between 1888 and 1891. Peirce's contribution to the Century Dictionary was massive. He was responsible for six major subject areas-logic, metaphysics, mathematics, mechanics, astronomy, and weights and measures-but he contributed to many other areas including color terms, general philosophy, geodesy, psychology, and education (in particular, the words related to universities). Altogether he probably contributed or approved over 15,000 definitions, with many of them taking many hours of thought and research. “

Houser, Nathan. Writings of CSP, vol. 6, lvii-lix

Peirce's semeiotic information

One of his definitions was “Information”:



information, an information; the document or pleading stating the ground of complaint.—Criminal information, in *law*. See *criminal*.—Ex officio informations, in *Eng. law*, the term by which purely public prosecutions by information were designated (usually had in the Queen's Bench), as distinguished from *crown informations*, which prosecutions in the interest of private or

The sum of synthetical propositions in which the symbol is subject or predicate is the *information* concerning the symbol. *C. S. Peirce.*

Peirce's semeiotic information

Peirce's concept of information is at the same time:

1) Logical in the traditional sense ("the aggregate of characters predicated of it over and above what is implied in its definition", as already found in the works of the nominalist Abelard)
2) Semeiotic as the expanded doctrine of logic ("the sum of synthetical propositions in which the symbol is either subject or predicate").
3) Metaphysical ("the imparting of form to matter")

First aspect:

Information in the traditional logic

Peirce's semeiotic information

As early as 1865, when he was 26 years-old, Peirce introduced information as a third logical quantity of *terms*. The two others were the traditional comprehension and extension (depth and breadth; connotation and denotation). This first formulation was:

- Kantian (How can we explain a priori synthetical judgments?)
- Mentalistic
- Nominalistic
- Concerned with scientific inferences (hypothesis and inductions) – i.e., **synthetical** judgements.
- Symbolistic, but not semiotic

*** Experience was not a major concern yet.

Peirce's semeiotic information

In this early period, terms are defined as symbols that can assume the role of subjects and predicates in propositions.

(...) symbols or general representations (...) connote attributes and so connote them as to determine what they denote. To this class belong all *words* and all *conceptions*. Most combinations of words are also symbols. A proposition, an argument, even a whole book may be, and should be, a single symbol.
(Peirce 1866, Lowell Lecture 7, CE 1, 467–468).

Information is the quantity connected to the interpretant of symbols : this would be the basis of his pragmatic maxim.

Peirce's semeiotic information

We then arrive at Peirce's "Abelardian" definition of information:

"The information of a term is the measure of its superfluous comprehension. That is to say that the proper office of the comprehension is to determine the extension of the term. For instance, you and I are men because we possess those attributes — having two legs, being rational, &c. — which make up the comprehension of *man*. Every addition to the comprehension of a term lessens its extension up to a certain point, after that further additions increase the information instead."

(Peirce 1866, Lowell Lecture 7, CE 1, 467).

Peirce's semeiotic information

An example:

"Thus, let us commence with the term *colour*; add to the comprehension of this term, that of *red*. *Red colour* has considerably less extension than *colour*; add to this the comprehension of *dark*; *dark red colour* has still less [extension]. Add to this the comprehension of *non-blue* — *non-blue dark red colour* has the same extension as *dark red colour*, so that the *non-blue* here performs a work of supererogation; it tells us that no *dark red colour* is blue, but does none of the proper business of connotation, that of diminishing the extension at all." (Peirce 1866, Lowell Lecture 7, CE 1, 467).

Peirce's semeiotic information

Peirce accepts the Abelardian definition of information and adds it to the traditional two quantities of logic

Instead of Comprehension x Extension

Peirce makes it Comprehension x Extension = Information

“If we learn that S is P, then, as a general rule, the depth of S is increased without any decrease of breadth, and the breadth of P is increased without any decrease of depth.” (CP 2.420)

Peirce's semeiotic information

In sum, in the 1860's, information for Peirce is a correlate quantity of a triadic relation which also includes extension (all real things that can be predicated by a **symbol**) and comprehension (all general predicates involved in the definition of a symbol). Information is the growth of either extension or comprehension without the diminishing of the other.

From now on, we will see Peirce understanding that not only symbols, but also indices (quantifiers) and then icons (diagrams) are important for a complete theory of information.

Second aspect:

Information in Semeiotic and Experience

Peirce's semeiotic information

Beginning in the 1870's (when he wrote his famous cogntive series of articles), Peirce's concept of information became an important part of both his theory of perception and cognition

- "Perception is the possibility of acquiring information, of meaning more." CP 7.587

- "… three elements of consciousness: 1st, Feelings or Elements of comprehension; 2nd, Efforts or Elements of extension; and 3rd, Notions or Elements of information, which is the union of extension and comprehension." (CP 7.580)

Peirce's semeiotic information

Peirce´s theory of perception:

- Sensation is a perceptive judgement
- Perceptive judgements are non-conscious abductions
- Abductions are synthetical inferences capable of producing mental habits (beliefs).
- So, non-conscious synthetical inferences produce beliefs during perception.
- Information is a quantity fundamental for the distinguishability of differences in perception during habit formation (belief formation).

***The strength of a belief is the logarithm of the chance involved.

On Small Differences in Sensation (First published in *Memoirs of the National Academy of Sciences, 3,* 73-83. Presented 17 October 1884)

Peirce's semeiotic information

"Any quantity which varies with the chance might, therefore, it would seem, serve as a thermometer for the proper intensity of belief. Among all such quantities there is one which is peculiarly appropriate. When there is a very great chance, the feeling of belief ought to be very intense. Absolute certainty, or an infinite chance, can never be attained by mortals, and this may be represented appropriately by an infinite belief. As the chance diminishes the feeling of believing should diminish, until an even chance is reached, where it should completely vanish and not incline either toward or away from the proposition. When the chance becomes less, then a contrary belief should spring up and should increase in intensity as the chance diminishes, and as the chance almost vanishes (which it can never quite do) the contrary belief should tend toward an infinite intensity. Now, there is one quantity which, more simply than any other, fulfills these conditions; **it is the logarithm of the chance**." (CP 2.676. my emphasys)

An even chance (1/1) means a probability of (1/2). Peirce calls it "randomness".

Peirce's semeiotic information

In 1884, Peirce and his student Oscar Mitchell (Studies in Logic) discover quantification independently of Frege

Information and the sign typology:

In his semeiotic, or “general doctrine of signs”, the information must be:

- Embodied by an icon
- Denoted by an index (quantifier)
- Conveyed by a symbol

Peirce's semeiotic information

Dicent symbols (propositions) are by their own definition always informative signs.

Deduction comes into play in his theory of inquiry: “A Necessary Deduction is a method of producing Dicent Symbols by the study of a diagram”. CP 2.267

Reasoning now involves abduction, induction and deduction:

“The purpose of reasoning is to proceed from the recognition of the truth we already know to the knowledge of novel truth.” (CP 4.476)

Peirce's semeiotic information

Essential properties of his semeiotic information:

- Information can be extracted from diagrams (coded relations) by reasoning.
- Information is modal and relative to a Universe (real or **fictional**)
- Information is relative to a state of knowledge about **such** Universe.
- There must always be COLLATERAL information (familiarity) about the object represented by the symbol, be it real or fictional.

Peirce's semeiotic information

(…) by collateral observation, I mean previous acquaintance with what the sign denotes. Thus if the Sign be the sentence "Hamlet was mad," to understand what this means one must know that men are sometimes in that strange state; one must have seen madmen or read about them; and it will be all the better if one specifically knows (and need not be driven to presume) what Shakespeare's notion of insanity was. All that is collateral observation and is no part of the Interpretant.

Peirce's semeiotic information

But that which the writer aimed to point out to you, presuming you to have all the requisite collateral information, that is to say just the quality of the sympathetic element of the situation, generally a very familiar one -- a something you probably never did so clearly realize before -- that is the Interpretant of the Sign, -- its "significance.” (CP 8.179)

Peirce's semeiotic information

The Object of the sentence "Hamlet was insane" is the Universe of Shakespeare's Creation so far as it is determined by Hamlet being a part of it . CP 8.178

The dicent symbol “Hamlet is mad” has information because it increases the breadth of the term mad while it increases the depth of the term Hamlet.

Peirce's semeiotic information

Collateral information

- depends on a “mental habit”, or belief that grounds the meaning of all predicates implied in the definition of a symbol.
- provides de adequate comprehension of a symbol.

- Has a “readyness” based on the logarithm of chance involved.

Peirce's semeiotic information

An interesting variation:

(…) a constituent of a Symbol may be an Index, and a constituent may be an Icon. A man walking with a child points his arm up into the air and says, "There is a balloon." The pointing arm is an essential part of the symbol without which the latter would convey no information. But if the child asks, "What is a balloon," and the man replies, "It is something like a great big soap bubble," he makes the image a part of the symbol.

(Peirce: CP 2.293)

In this case, collateral information was produced to the child by the man. The strength is given by authority.

Peirce's semeiotic information

"By information I mean all that knowledge that we collect from the experience of ourselves and of others. Now I call any acquisition of Knowledge "information", which has logically required any other experience than experience of the meanings of words. I do not call the knowledge that a person known to be a woman is an adult nor the knowledge that a corpse is not a woman, by the name of "Information", because the word "woman" means a living adult human being having, or having had, female sexuality. Knowledge that is not Informational may be termed "verbal". (Peirce, 1910, MS 664 -19)

Third aspect: Information as the imparting of Form to Matter

Peirce's semeiotic information

From 1890's on, Peirce revised his previously nominalistic theory of information and made it increasingly realistic.

- There are real natural classes
- The symbol is an embryonic reality
- Information is the growth of symbols
- Mind is universal. Matter is just effete mind.
- The form is a "would-be"
- Information is development, increase of complexity in reality.

Peirce's semeiotic information

"Analogous to increase of information in us, there is a phenomenon of nature-- development-- by which a multitude of things come to have a multitude of characters, which have been involved in few characters in few things." CP 2.420- 1883

Peirce's semeiotic information

"Consider the life of an individual animal or plant; or of a mind. Glance at the history of states, of institutions, of language, of ideas. Examine the successions of forms shown by paleontology, the history of the globe as set forth in geology, of what the astronomer is able to make out concerning the changes of stellar systems. Everywhere the main fact is growth and increasing complexity." (EP1 307-8)

Peirce's semeiotic information

"From this point of view we must suppose that the existing universe, with all its arbitrary secondness, is an offshoot from, or an arbitrary determination of, a world of ideas, a Platonic world (CP. 6.192). The evolutionary process is, therefore, not a mere evolution of the existing universe, but rather a process by which the very Platonic forms themselves have become or are becoming developed". (CP 6.194)

Peirce's semeiotic information

In a late MS, Peirce explains what he understand by the word “symbol” as to leave no doubt that he is not classifying his semeiotic as a branch of social psychology, or even anthropology at large. It is an undated but certainly late manuscript fragment (MS 797), for example, Peirce brings up the most important features of the nominalistic definition of symbol (a manmade diadic match-word, arbitrary, conventional), but then explains how he himself departs and expands from it to embrace his realistic account of signification:

Peirce's semeiotic information

"Symbols: The word "symbol" has already many meanings; and I shall ask leave to add a new one. Among its early significations, perhaps the original one, is that of a match-word, a somewhat arbitrarily adopted word or phrase, by which persons of one party recognize one another. It is nearly in this sense that the church creeds are called symbols. So a flag is a symbol, etc. I think, then, that I shall not wrench the word too much if I use it to mean a sign to which a general idea is attached by virtue of a habit, which may have been deliberately instituted, or may have grown up in a natural way, and perhaps have been acquired with one's mother milk, or even by heredity".

Peirce's semeiotic information

The central point in defining a Symbol is that the Form it communicates is the nature of a conditional future:

“To this may be added the consideration that it is not all signs that have logical interpretants, but only intellectual concepts and the like; and these are all either general or intimately connected with generals, as it seems to me. This shows that the species of future tense of the logical interpretant is that of the conditional mood, the "would-be.” (CP 5.482)

Peirce's semeiotic information

Objects like a die or a coin are real possible symbols because they have “habits”

“…the die has a certain "would-be"; and to say that a die has a "would-be" is to say that it has a property, quite analogous to any habit that a man might have. Only the "would-be" of the die is presumably as much simpler and more definite than the man's habit as the die’s homogeneous composition and cubical shape is simpler than the nature of the man's nervous system and soul;

Peirce's semeiotic information

and just as it would be necessary, in order to define a man's habit, to describe how it would lead him to behave and upon what sort of occasion--albeit this statement would by no means imply that the habit consists in that action--so to define the die's "would-be," it is necessary to say how it would lead the die to behave on an occasion that would bring out the full consequence of the "would-be"; and this statement will not of itself imply that the "would-be" of the die consists in such behavior.

(CP 2.664)

Peirce's semeiotic information

“Consequently, the external world, (that is, the world that is comparatively external) does not consist of existent objects merely, nor merely of these and their reactions; but on the contrary, its most important reals have the mode of being of what the nominalist calls "mere" words, that is, general types and would-bes. The nominalist is right in saying that they are substantially of the nature of words; but his "mere" reveals a complete misunderstanding of what our everyday world consists of.” (CP 8.191)

Peirce's semeiotic information

Is Peirce's information logarithmic?

(Knowledge has a "money value" that) increases with the fullness and precision of the information, but plainly it increases slower and slower as the knowledge becomes fuller and more precise. The cost of the information also increases with its fullness and accuracy, and increases faster and faster the more accurate and full it is. It therefore may be the case that it does not pay to get any information on a given subject; but, at any rate, it must be true that it does not pay (in any given state of science) to push the investigation beyond a certain point in fullness or precision. (Peirce: CP 1.122)

Peirce's semeiotic information

"…the game of twenty questions is instructive. In this game, one party thinks of some individual object, ***real or fictitious*** *(my emphasis)*, which is well-known to all educated people. The other party is entitled to answers to any twenty interrogatories they propound which can be answered by **Yes** or **No**, and are then to guess what was thought of, if they can. If the questioning is skillful, the object will invariably be guessed; but if the questioners allow themselves to be led astray by the will-o-the-wisp of any prepossession, they will almost as infallibly come to grief. The uniform success of good questioners is based upon the circumstance that the entire collection of individual objects ***well-known to all the world*** (*my emphasis)* does not amount to a million.

Peirce's semeiotic information

If, therefore, each question could exactly bisect the possibilities, so that yes and no were equally probable, the right object would be identified among a collection numbering 2^{20}. Now the logarithm of 2 being 0.30103, that of its twentieth power is 6.0206, which is the logarithm of about 1,000,000 (1+.02x2.3) (1+.0006x2.3) or over one million and forty-seven thousand, or more than the entire number of objects from which the selection has been made. Thus, twenty skillful hypotheses will ascertain what two hundred thousand stupid ones might fail to do. The secret of the business lies in the caution which breaks a hypothesis up into its smallest logical components, and only risks one of them at a time." (Peirce: CP 7.220)

Peirce's semeiotic information

Collateral experience gives us the real probability distribution of some state of affairs, objects etc in a system (possible universe).

This is the comprehension related to the general representation (symbolic) we have about such system.

Every question Yes or No corresponds to an hypothesis to be tested in an inquiry.

Hartley Information

In 1928 Hartley introduced a simple measure of information. When one message is chosen from a finite set of equally likely choices then the number of possible choices or any monotonic function of this number can be regarded as a measure of information.

Hartley pointed out that the logarithmic function is the most ``natural" measure.

Peirce's semeiotic information

WILD GUESSES....

Peirce's information in relation to the MTC:

- depends on previous knowledge and the probabilities involved in the predictable events. This predictability (belief) **can be** mesured as a logarithmic quantity.
- Reduces the redundancy in a community of inquirers by the increase of novelty and complexity
- Can denote the object of a symbol (such as the outcome of a flip of coin or die) by hypothesis answered by either yes or no.

Thank you!