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SEMIOTICS OF ARTIFICIAL INTELLIGENCE

In an encounter between Noam Chomsky and David Premak[1], Chomsky,
who is professor at the department of linguistics and philosophy
at MIT, said:"Do humans or other creatures spontaneously use
mentally represented or physical symbols to encode experience,
carry out thought and perform perceptual judgements? We probably
agree on what we expect to find. Symbolic representation in this
sense is not specifically human, by no means specific to human
language". That implies that symbolic representation, indexes, and
pointers are inherent in information as such, and also in information
processing. Further Chomsky: "I think a fair amount is known about
that. It involves a finite system of recursive rules of computation
with very non-trivial properties that allow, for example, for
infinite naming with embedded propositional contend, and so on".

If structures and networks are the basics of information processing,
then semiotics can be seen as basics for structures and networks
(in the context of information processing). With that we are back
at the mechanics involved in the communicative aspects of the
semiotical representational schemes.

At the present time semiotics are employed as pure, as well as
applied sciences[2]. Therefore, sometimes the theoretical, and
sometimes the pragmatical aspects are in discussion; however, this
should not mislead to an interpretation of semiotics being a
deductive theory, which holds true for certain parts of mathematics
(number theory, algebra), and theoretical mechanics, but becomes
quite doubtful in the realm of logic as shown by F. Weismann (in
opposition to Russel and Whitehead[3]).

In its present form, semiotics is not a deductive theory which
could be constructed axiomatically, but rather part of an
abstracting theory, of empirical origin, which basics are
reconstructable, consolidated, and of limitless operationality.

On account of the fact that semiotics is a thoroughly thetical
(designated), and not a given reference system, it is determinated
accordingly, i.e., in the sense of its existing, and readily
functionally operating thetical parts.

Both, the sign as well as information per se, do not occur in
nature, and are not subjects of the natural sciences. Nevertheless,
communication of information (in a general sense) requires energetic
or material signs and their carriers which combined result in
signals, and signal functions. However, this is not the subject of
discussion, because not a 'physical' channel is investigated, but
one of 'software' in which information 'flows', and without it no
information processing can take place. In other words, a third
kind of an element next to matter and mind will be the 'container'
of information. Nevertheless, all the aspects and phenomena of
information theory have counterparts in the natural sciences[4].

Only in respect to it's threefold (substitutional) functions of
representation, communication and foundation schemes is a sign a
"tool" and semiotics an "organon" in Wittgenstein's sense (Bense).
That is to say, we have here not a deductive but an operational
theory and it's theorems are not only rules for intellectual
handling, but are methodical, constructive, executable functions
in action. The thetical introduction of signs in this respect is
just such an intelligent manipulation as is the selection of a
pre-semiotically set repertoire. Producing the relationship between
designated object and interpretant as context or connex out of the
same repertoire, for instance, is also just such an intelligent
manipulation.

All operational theories are pragmatic ones, and so is the theory
of semiotics. As Peirce already formulated, all pragmatically
oriented theories have a stronger bound to selectivity,
acceptability and applicability than formal theories. Hence,
applicability demonstrates acceptability; however, without
previous selective acceptability, direct applicability is not
possible.

These considerations demand a close look into the pragmatic

concept of art, and a semiotic analysis of the "aesthetic state" which was developed by M. Bense[5]. In that process, based on Peirce's ten sign-classes, he extrapolated the now wellknown

$$Sc(ae): (3.1 \quad 2.2 \quad 1.3);$$

that means a rhematic sign class with rhematic, indexical, legi-sign. This is an intermediate sign class of the maximally mixed type and evenly distributed basic categories ("firstness", "secondness", and "thirdness" appear each one twice); only the complete (TS) sign has such an even distribution of basic categories, namely six times.

The "aesthetic state" of semiotics, and the aesthetic state of an object as in the case of aesthetic measurements, or the aesthetics involved in numerical aesthetics are not to be confused with each other. Ordinary aesthetics are always related to an object, as is the case in numerical aesthetics:

$$M = \frac{O}{C}$$

where 'O' represents the organizational relationship, and 'C' the relative count designating complexity. According to Bense et al. (Die Unwahrscheinlichkeit des Aesthetischen), the relationship between redundancy, and intrinsic information generates the elements of aesthetics. But if such is the case, then all symmetrical objects do have 'a priori' redundancy (because of the law of symmetry) in relation to intrinsic information in ratio of 2:1, and so will bring about an inherent disadvantage to all asymmetrical objects. However, that is not a point to be discussed here. Important is that as Peirce, Bense et al. pointed out, not the object per se is the subject of semiotics, but its very existence (the objects) as such, and that, of course, has an indexically (2.2) oriented object relationship through the 'channel' (1.3) as legi-sign in rhematic (3.1) context.

It must be differentiated between the semiotic representation of the "aesthetic state" (aeS), and the semiotic representation of the given (presented) aesthetic object itself (aeO). Within the triadic

9

relationship, only the index "points" at the "aesthetic state".

Sc(aeS): (3.1   2.2   1.3); and

the real, presented art object is designated as:

Sc(aeO): (3.1   2.1 / 1.2).

The basis of unspeculative, unhypothetic but theoretically ab-
stracting, operationally reconstructive semiotics, is in fact that
 what it is only because the origin, the foundations of functions,
and methodical processes are fundamental by nature: thetical,
selectively executable functions. However, just in these thetical
principles are the elements necessary for the creation of art and
the point where semiotic description touches art. The evident
semiotic process involved is thetic, selective, hierarchical
supersetting, constructed of material repertoires; these do indeed
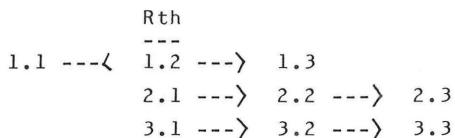indicate the semiotic origin of art.

These allow the art object to function as representing art object
and communicating sign system at the same time. That is what
legitimizes semiotical aesthetics as categorical, founding scheme
of the numerical aesthetics and allows us to include aesthetics in
the general theory of semiotical "mechanics", and the various
processes involved in the communicative aspects of semiotics.

The reality thematics of the 'aesthetic state', as already mentioned
in the first part of this paper, is:

                          Rth

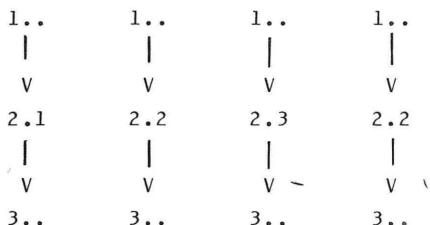   1.1 ---< 1.2 ---< 1.3
                         2.2 ---> 2.3
                         3.1 ---> 3.2 ---> 3.3

The generative semiosis which takes place from index to symbol,
and from rhema to dicent to the argumental state is obvious.
Looking at the reality thematics of the object:

10

```
                        Rth
                        ---
          1.1 ---<   1.2 --->  1.3
                     2.1 --->  2.2 --->  2.3
                     3.1 --->  3.2 --->  3.3
```
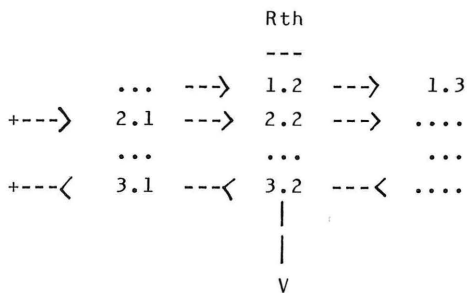
it becomes clear that this is a medium-thematized object. In the
reality thematics of the 'aesthetic state', we had the vector of the
complete sign known also as the 'pragmatic aspect'. The sin-sign,
icon, and rhematic interpretant are the characteristics of the
(medium thematized) object. An inspection of both above structures
will show that 'aesthetic state' and object are related by the
pointer index primarily, and medium sin- to legi-sign modification.
This fact may prove that 'aesthetic state' is related to perception
(not just a 'pure' theoretical term) within the framework of the
communicative functions, and implicitly at least of the human mind.

```
          1..        1..        1..        1..
           |          |          |          |
           V          V          V          V
          2.1        2.2        2.3        2.2
           |          |          |          |
           V          V          V ~        V
          3..        3..        3..        3..
```

Ideas can be communicated only via icon signs (2.1), and also all
indirect communication is dependent on the icon sign. That is why
each statement must consistently employ one or more icon signs, or
include such signs which again can be explained only with the aid
of icon signs. A case in fact is the spoken language in which
vocal signals as signs are to be explained only by way of icon
signs. Therefore, all perception involves the icon sign (2.1) and
its processing.

This implies that as long as the processing of visual perception,
visualizing thoughts or both at the same time take place (as when
reading a descriptive text) the semiotic (communicative) functions
involved are those of a rhematical sign interpretant on the one
hand, and those of the legi-sign medial (channel) on the other
hand. The increments which are characteristic for a generative

semiosis, namely, from the icon (2.1) through index (2.2) to the
symbol (2.3), begin at the medium thematized object (3.1.,2.1.,1.2),
and end at the interpretant thematized medium (3.1.,3.2.,1.3). On
close inspection it becomes quite obvious that the 'aesthetic
state', (3.1.,2.2.,1.3) is just the missing link, i.e., the inter-
mediate state in which the medium-thematized object (perceived or
visualized), is in an "status nascendi", where the index 'points'
to the 'address' of a symbol (2.3) which perhaps is not readily
available, and so stops the semiosis in process in a kind of
resonance or oscillation (the actual semiotical aesthetic state)
between icon and index. If the cycle is completed, and the index's
'pointer' finds the right symbol, nothing stands in the way for
the channel to give a positive response by means of incrementing
its state from sin-sign (1.2) to legi-sign (1.3) and so arriving
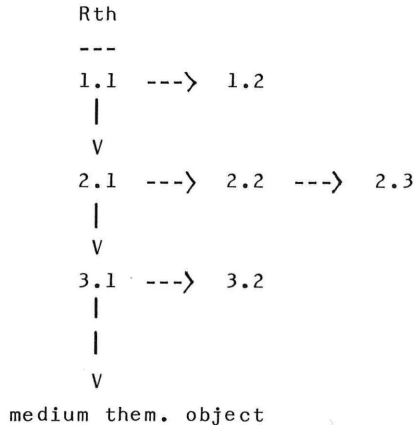at its goal.

```
                        Rth
                        ---
              ...  --->  1.2  --->   1.3
        +--->  2.1  --->  2.2  --->  ....
              ...        ...         ...
        +---<  3.1  ---<  3.2  ---<  ....
                          |
                          |
                          V
```

                  The complete object

According to Peirce, a sign may appeal to its dynamic interpretant
in three ways:
1st, an argument may only be submitted to its interpretant as
something, the reasonableness of which will be acknowledged. That
could mean fulfilled semiosis with positive acknowledgment.
2nd, an argument or dicent may be urged upon the interpretant by
an act of insistence. This could be seen as interrupted semiosis.
3rd, argument or dicent may be, and a rhema can only be, presented
to the interpretant for contemplation. This would mean that
semiosis is not fulfilled because of 'negative response' due to
wrong "interpreting address", and as a result an oscillation takes
place between semiosis and retrosemiosis. To continue the

speculation in this direction it could be said that as long as
visual perception, visualizing thoughts or both are engaging the
conscious mind in processing 'picture' thoughts, the semiotic
vectors (as parts of the semiotic matrixes) involved move around
a 'fixed' axis of the rhema-sign interpretant; (This is still the
communicative function aspects of the sign on the one hand and the
legi sign of the medium on the other. The functions of the medium
remain at the sin-sign point while the processing of one item
takes place, and then changes to legi-sign. The object's function
transfers from icon to index to symbol. A symbol not found (no
change from 1.2 to 1.3 in the channel) or wrong symbol (address)
may trigger a retrosemiosis only to turn into another symbol, and
perhaps, if no interference comes up from another source, to
conclude the cycle, before the next one begins.

```
            Rth
            ---
            1.1  --->  1.2
             |
             V
            2.1  --->  2.2  --->  2.3
             |
             V
            3.1  --->  3.2
             |
             |
             V
      medium them. object
```

In set theory as developed by Georg Cantor, a set is defined as a
collection of real or abstract objects. Sets, such as the set of
all real numbers, for instance, are by their very nature actual
infinities, and impossible to visualize abstractions. Although
there are profound obscurities with regard to the precise meaning
of the theory of transfinite (aggregate) numbers in which no
inconsistency is discoverable, it gives rise to problems deeply
involved with questions concerning the foundations of mathematics.
It may, however, be argued that there is no more to the "existence"
of transfinite numbers than the possible existence of aggregates

13

exemplifying any and every finite number in their proper parts, and that we perfectly understand what this means. From such a view, the main use of Cantorian concepts is to dispel the atmosphere of awe and mystery attached to the mathematical infinite, and to restore it to those ethical, aesthetic and religious objects to which it more properly belongs[6].

In semiosis, in case a symbol (absolute subjective) has been 'stored' and may be 'found', semiosis will take place, otherwise the mind goes into the (semiotical) 'aesthetic state' (aeS). Now consider a set of five elements, say five apples. There is no problem to visualize five apples, but if the set of elements (or apples) is increased to say five millions or, for that matter, five billions, the human mind goes into the (semiotic) 'aesthetic state' because of the unfulfilled semiosis, and because semiotic selection did not take place between the object-index-symbol on the one hand, and sin-legi quali-sign on the other, as already explained above. This implies that the semiotical 'aesthetic state' and the notion of fuzzy sets have common roots, and perhaps involve the same semiotical mechanics when analyzed for their communicative aspects.

The autoreproductive creation of iterated sub-signs points to the scheme in which the semiotic representation is performed by triadic trichotomic relationships, such as for instance, those of M, OM, and IM. However, in the "actual" process of semiosis (the instance the 'crossover' takes place between the various triadic trichotomic positions) the sub-signs function as inter-mediate values of representation and so ordain the system of trichotomies to an ordinal system for mediation between triadic main references of representation. Therefore, looking at the 'status nascendi' semiotical instance, we could say that the processes of semiosis should be considered, in their *generality*, *as being fuzzy*.

Now a discussion on information (general) meaning and the
relationship between information processing and semiotics is made
in order to speculate and perhaps be able to explain how semiotic
elements (in their communicatitive aspects) are stored or "written"
in general and also in particular in the human body. Logically, the
same operations are made to explain the semiotic aspects of function
as used in information retrieval, information processing, and
therefore most probably analogous to the processes that take place
in the human mind.

In reality, the mind-ego relationship is a potential triadic-tricho-
tomic sign-relationship (Bense), where semiosis and retrosemiosis
are expressed by means of complete semiotic matrixes. The
connection between the perceiving "I' and the cognizance of the
"world" (in total as in detail) are graded representations of
"software" (semiotic frames) within the theory of science[7], and
therefore it should be possible to build a model of the mind at
any level.

The following quotation from Peirce gives reason to think that the
idea of using signs of objects as pointers to signs is imbedded in
the meta-theorem with which Peirce formulated Pragmatism.

The philosophy of pragmatics was defined by Peirce (Popular
Science Monthly,- 1878,) as follows:
"Consider what effects, that might conceivably have practical
bearings we conceive the object of our conception to have. Then
our conception of these effects is the whole of our conception of
the object". That statement although a meta-theorem expresses the
basic idea of the relationship between pragmatics and semiotics
as does the following statement by Peirce[8]: "The next moment of
the argument for pragmatics is the view *that every thought is
a sign.*" (CP 5-11-13. pp. 274)

Each and every sign is imbedded in a network of signs, where each
and every sign has its own discrete meaning that could be
approached only by way of other signs. The notion of interpretation

15

implies that the interpretant is the interpreted sign as well as
the interpreting one. In other words, a sign functions as
something interpreting another sign (sense) and at the same time
as something requiring interpretation. In his letters to Lady
Welby[9] Peirce explains his idea of the interpretant so:

"My immediate interpretant is implied in the fact that each sign
must have its peculiar interpretability before it gets any
interpretant. My dynamical interpretant is that which is
experienced in each act of interpretation and is different in each
act from that of any other; and the final interpretant is the one
of interpretative result of which every interpreter is destined
to come if the sign is sufficiently considered. The immediate
interpretant is an abstraction, consisting in a possibility. The
dynamical interpretant is a single actual event. The final inter-
pretant is that toward which the actual tends. (Correspondence,
III)".

There is no ambiguity in Peirce in defining the interpretant
(sign) as a meaning of the initial sign and simultaneously as the
next sign interpreting the first in a chain of signs.

The semiotic mechanistic theory offers a model for the essentially
conjectural character of logical induction and the semiotical
aesthetic state; processes which resemble the selection and then
the shuffling-together of a limited number of tentative "facts"
through which information "moves". It could be said that induction
is not a problematic formulation nor an inadmissible act in logics,
but is a discoverable physical process within the framework of
semiotics in the communication scheme, primarily in the function of
transmission of information, i.e., transmission of data between
source and sink via a 'channel'.

Information received by the senses is filtered and compressed
before perception really takes place and gives rise to the index
sign (2.2). It could be said that the index sign is a "compressed"
(2.1).2.2   icon sign (as is the relocatable label pointing to
the object of a routine in computer programming); however, the
index is actually more than a 'pointer' to a symbol sign. As Peirce

16

already noted: only the index sign can be dynamic, connected at one end with an object and at the other with the mind; hence,it must have a 'range' of its own positions.

In communicative aspects of semiotic classes, 'firstness' plays the important roll of being

a) Channel,
b) Carrier that flows in the channel,
c) Code, i.e. the modulation of the carrier,

which is

Quali-sign   Sin-sign   Legi-sign = Medium

News, information, is something we receive by means of pictures or language which could be spoken or read, i.e. audible or visual perception, in which formerly agreed-upon (society, environment) key 'signals' from a learned repertoire are recognized and assimilated. Perception is a semiotic process in which selection takes place.

For instance 'the notion, - rain. The audible noise of the rainfall, the observation of it, the written word "rain" and the spoken word "rain", all those different stimuli of the various senses will 'address' the same symbol sign in the interpretant.

1... ⟩⟩⟩ 2... ⟩⟩⟩ 3... ⟩⟩⟩ 3.3

A symbol is a 'representamen' the representing characteristics of which are those of interpretation. From this it can be inferred that the icon sign as well as the index sign are imbedded in the symbol sign. Hence, we can postulate that thinking is nothing else than the processing of signs, i.e. algorithmic functions involving and resulting in symbols. Whenever new symbols are created, we speak of conceptual thinking; therefore, concepts are symbol signs. "Omne symbolum de symbolo", or symbols generate symbols.

Semiotic operations involve the time axis as all 'real time' functions do, and as does the conscious thinking mind which is

17

semiotically classified as an 'interpretant', a 'thirdness' in the sense of Peirce and Bense, independent of the repertoire (memory) on the one side and the object - the thing - on the other side.

The sign is a one-positional existential function, (ontofunctor to Bense) into which a thing could be 'imbedded', i.e. which relates to a thing. However, if the thing (icon) has been already indexed, then the sign (code) for that thing has a semiotic double value, then it is a two-positional existential function[10].
The conscious human mind is a two-positional existence function (ontofunctor to Bense) where two things are introduced, namely source and sink or object and subject which must relate to each other by means of a medium. Therefore, the mind is a three-positional existence function. An analogous comparison could be made, for instance, by analysing what takes place i.e. what is involved by watching a movie, where three elements interact: The things (icons) shown, the light projection (medium), and the screen (the mind). Each of these elements is again trichotomically compounded, like the medium 'light' has three branches, photons as carrier of information is the quali sign (1.1), the unique shadows, faces and shapes are the sin signs (1.2) and the light modulation (wavelengths or code) is the legi sign (1.3).

In order to be able to identify an expression as false, perceived information must contain statistical innovation (news). It has been claimed that information and meaning are two mutually exclusive notions in linguistic conception from the standpoint of statistical information theory. This, of course, implies intentional "meaning" and statistical "information" to be in reciprocal, complementary relationship with each other; in other words, the innovative character of information is in oposition to the meaning of the intuitive evidence. That could not be true because innovation is determined by the size of information as the intuition is by the size of intention.   .

Every change that occurs spontaneously from within in any physical complex system increases the degree of the system complexity. It is as in the second law of thermodynamics which is a summary of

18

physical experimental compendium and not based on principals
(BRE vol. 18 p. 673). Each spontaneous change in a physical system
is a change in the direction of increasing entropy, where the final
equilibrium is equal to the maximal possible value which the
entropy can accommodate; hence, all reactions are irreversible where
entropy is involved (see Thomson). In information processing, these
rules work in the opposite direction, from disordered maximal
possible values to ordered minima. Pattern recognition, for
example, is a quest for the minimum entropy, whereby our system of
categories used in the representation of data is to be adaptively
adjusted and the entropy suitably defined.

An analogy of that relationship is perhaps suggested in the non-
linear irreversible processes of thermodynamics[11]. Take the case
where the creation of information by statistical selection (by
chance) out of a sign repertoire is made, and where all signs are
evenly distributed like the particles in a space filled with gas.
In the case of particles (gas) the entropy will increase, in the
case of signs the entropy will decrease because the process of
creation (generation) of information from the source of original
disorder works in the opposite direction. There sequences of signs
become more and more organized. The even distribution of signs 'in
a language becomes uneven and those elements are created which
allow information, information processing and information transfers.
These functions are basically semiotic, i.e. general semiosis and
retro-semiosis are the foundation of information per se; therefore,
creation of information does involve "work" (in the sense of the
laws of thermodynamics).

According to the general theory of relativity, the energy 'E' of
a system is equal to the product of its mass 'm' and the square
of the speed of light 'c' in a vacuum, namely,

$$E = mc^2$$

By virtue of the first law of thermodynamics, the energy 'E' of
an isolated system is conserved. Therefore, the above equation
requires that the mass 'm' of the system is also conserved,
regardless of the processes occurring within the system (such as

19

chemical reactions, nuclear reactions and creation and annihilation of particles). Moreover, if the energy of a system is altered by virtue of an adiabatic or non-adiabatic interaction, the mass of the system must also be altered in accordance with the equation. In most applications, the energy transfered to or from a system is so much smaller than the total energy 'mc^2' of the system that the change in mass is negligible especially if energy is continuously supplied to the mass by way of electromagnetical or material means.

Many applications of thermodynamics involve interactions between systems, some or all of which are passing through non-equilibrium states. For example, chemical and nuclear reactions and flow of energy and matter are processes occurring in systems passing through non-equilibrium states. The analysis is very difficult, both conceptually and numerically, compared to that of stable equilibrium states; hence, most calculations restrict themselves to systems in steady states having fixed time-rates of change of extensive properties.

In 1977, Ilya Prigogine, a Russian-born professor at the Free University of Brussels, won a Nobel Prize in Chemistry for proving that the second law does not apply to "open systems" such as living creatures, because living things can acquire new energy. Plants grow healthy by soaking up sunlight, even though the sun, the source of the solar system's energy, is slowly burning out.

In many systems, the number of elements (particles) is uncertain either because the system is open to the transfer of rest mass or because elements (particles) can be created and annihilated within the system. The terminology of Gibbs suggests that such systems be called grand systems, or complex system[12], imbedded into an hierarchy which has its own complexity and where at the summit the individium reigns supreme.

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4 *In this connection see 'Essays' on the use of 'Information theory in biology', edited by Henry Quastler, University of Illinois Press, Urbana, Ill., 1953*

5 *Max Bense, Aesthetica, Agis Verlag, Baden-Baden, 1976.*

6 *"Finitism in Mathematics", A. Ambrose, Mind, vol. XII, 1935.*

7 *The term epistemology is not used here because of the inherent dualism between object and subject in contrast to the triadic representation in the theory of science.*

8 *C.S. Peirce, "A New List of Categories", (1867), C.P. 1.545-559*

9 *P.P. Wiener, "Charles S. Peirce Selected Writings", Dover Publication Inc. New-York, 1958.*

10 *Robert E. Taranto, "Semiotisches System-Modell und Bewußtseins-Prozesse", Dissertation Uni. Stuttgart 1979, pp. 46-47*

11 *According to the second law of thermodynamics, a system may start from any allowed state and reach the corresponding stable equilibrium state with no net effect on the environment. Such a process could not be reversible. For if it were, the system starting from the stable equilibrium state could undergo a process that ends at another state with no net effect on the environment. This conclusion, however, violates the definition of a stable equilibrium state. It follows that irreversible processes exist.*

12 *See: B.S. Fleischmann "On the optimal structure of Complex Decision Systems", and "On Survivability of Complex Systems" in Technical Cybernetics Nr. 3-4, USSR Academy of Science 1966.*

SEMIOSIS 31

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