Artificial Intelligence and Sign Theory

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Research in artificial intelligence is often regarded as pertaining to the fields of engineering or informatics. Intelligent robots, expert systems, automatic translators, so it is said, belong to the world of computer technology.But is this really the case? Even a cursory study will easily show that things are not that simple as a well orchestrated marketing would have us think. A deeper analysis of the problem would easily show that AI is much more an undertaking that pertains to formal and abstract discipline than to concrete and material technologies. The following essay will attempts to show that AI is in fact related intimately to abstract disciplines and, more specifically, to semiotics ;it is a applied semiotic venture.

AI's Territory,

The original objective of AI was to have the computer execute tasks or actions characteristic of living beings showing intelligent behavior. Promises of success were abundant. However instead of providing an abstract definition of the type of activities comprising AI,the discipline, for a long time, presented only an extensional list of practices that one could recognize as paradigms of AI projects. Thus, chess games, theorems proving, problem solving and the like became typical examples of AI ventures..

Later, projects on perception and pattern recognition were introduced. However, it was primarily with the introduction of natural language processing and robotics that the main trend of AI was deliniated. More recently, AI specialized its programs and systems to the degree that they were said to be expert with regard to such tasks such as medical diagnostics, chemistry and even physics analysis.

Even though, throughout its development, artificial intelligence has defined itself in concrete terms with projects of the 'high technology' type, it has also constantly aimed at arriving at a more abstract definition of its object. Allen Newell (1983),in a study of the historical development of this discipline, has shown how AI, after travelling through various paradigms, finally found its own route. Indeed, since its origin in the fifties AI has in turn to distinguished itself in turns from cybernetics, systems theory, pattern recognition, numerical computing, programming theory, electrical engineering, and finally, formal logic. It is only recently in the eighties that it seems to have arrived at a more precise delimitation of its own territory.

The Metaphor of Intelligence

If one analyses the various projects that have built the reputation of AI in an effort to distinguish its central preoccupation, it would not be too difficult to classify them under the predicates of 'projects simulating intelligent behavior by use of the computer'. Indeed, how is it possible not to describe a machine that plays chess as having 'artificial intelligence'. If in its origin this concept of intelligence was thought as a metaphor for describing a class of projects, it has now changed its status and position. Indeed, it is the computer itself that has now become the metaphor of intelligence and even, for many researchers a "model' of this intelligence:

"With a model of an information processing system, it becomes meaningful to try to represent in some detail a particular man at work on a particular task. Such a representation is not a metaphor, but a precise symbolic model on the basis of which pertinent specific aspects of the man's problem solving behavior can be calculated"
[Newell and Simon,1972, p.5]

"Artificial Intelligence has also embraced the larger scientific goal of constructing an information processing theory of intelligence"
[Nilson. 1980]

From this point, it there is only a small step to take to identifying this type of intelligence with MIND. For,is not being intelligent the main characteristic of a mind?

The Nature of ' Artificial ' Intelligence.

What does one understand by 'intelligent behavior''? Although, in the various AI projects, the rechearchers did not limit themselves in defining formally what intelligence was, they implicitly accepted a thesis on its nature-- a thesis that is highly traditional and which originates in Plato and Aristotle. To be intelligent is somehow to be "rational' as the old philosophers said. Intelligence is our modern way to translate the antique concept of "RATIO'. To to say that a behavior manifests some intelligence is to somehow recognize that it 'operates in a rational way',i.e., to to say in the original sense, it possesses a norm(RATIO) or follows some rules or has a structure of some sort. Actions that are rational are not purely arbitrary and haphazard ; they process in a systematic way.

Artificial 'intelligence' has been described according to various theories whose specific aim was precisely to represent these structures and rules of rationality. Such were the aims of the cybernetics, systems, logic, numerical algebra and computation theories. To think rationally, for a computer was seen as an activity that was modeled through these formalisms. In the seventies the works of Minsky and Papert (1973) Newell(1970,1973,1980, 1983) and Simon (1969, 1976,1979,1980), brought to this question some very important distinctions that contributed in radically delimiting the artificial intelligence territory and which have subsequently become the paradigm by which one understands or criticizes this enterprise. According to Newell (1983), one of the ways artificial intelligence has distinguished itself from the various other mathematical and computing disciplines is the fact that AI projects could be considered as dealing with a particular class of symbolic systems. According to this perspective, a project in AI is not primarily aimed at processing numbers but physical symbols.

"Scientist in AI saw computers as machines that manipulated symbols.The great things was, they said that every thing could be encoded into symbols, even numbers.'[Newell 1983: p 196.].

"The idea is that there is a class of systems which manipulate symbols. and the definition of theses systems which manipulate symbols is what is behind the programs in AI., " (Newell, 1986 : 33)

Hence, Newell defined AI as a "theoretical psychology permitting the programming of simulated intelligent behavior"

"Artificial intelligence is theoretical psychology, simulation (the running of a program purporting to represent some human behavior) is simply the calculation of the consequences of a psychological theory"
[Newell,1973: 47]

> *"Information processing psychology is concerned essentially with whether a successful theory of human behavior can be found within the domain of symbolic systems."[Newell, 1970: 372].*

Later on, Newell and Simon (1976) and Newell(1980,1986) refined this thesis in terms of 'systems of physical processing systems"

> *The idea is that there is a class of systems which manipulate symbols. and the definition of theses systems which manipulate symbols, and the definition of these system is what<s behind the programs in AI.The argument is very simple: We see humans using symbols all the time. They use symbol systems like books, they use fish s a symbol for Christianity, so there is a whole range of symbolic activity, and that clearly appears to be essential to the exercise of mind.Certainly, trying to understand the nature of symbols and symbolic behavior is an approach to the nature of mind, " (Newell, 1986 : 33)*

This is a original thesis and it contrasts with a purely materialistic if not reductionist conception of artificial intelligence. It says that what characterizes the operations of a computer manifesting "intelligent behavior' are not numerical operations regardless of how complex they may be, nor, to an even greater degree, operations achieving sophisticated mechanical or even electronical manipulations.Rather an intelligent computer is one that processes a special type of signs, i.e. to say symbolic ones. Hence, an artificial intelligence is a "machine" whose "rational" behavior consists of manipulating *physical symbols*? Such a thesis is radical and no longer situate AI within a theory related solely to material technology and engineering. On the contrary, it takes AI out of such a theory and inserts it,whether one likes it,or not within a semiotical theory. To understand this, let us examine further this thesis of artificial intelligence as a "physical symbols processing system".

In order to understand this thesis, we need to analyze the three implicit sub-theses it contains: 1- regarding the nature of the symbols themselves, 2- regarding the processing of these symbols and 3- regarding the interpretation of these symbols.

Sub-thesis 1: The Nature of the Symbols.

The first issue we face is the nature of these symbols.What kind of entities serve as symbolic signs?

> *"A physical symbol system consists of a set of entities, called symbols, which are physical patterns that can occur as components of another type of entity called an expression (or symbol structure)."*
> *[Newell,1976: 116].*

The physical nature of the symbols implicit in this definition needs to be underlined. The systems talked about are ones that can process physical symbols, not physical systems that can process symbols. For Newell, symbols have a material dimension.

> *"Thus a symbol structure is composed of a number of instances (or tokens) of symbols related in some physical way (such as one token being next to another).At any instant of time the system will contain a collection of theses symbols structures.' [Newell, 1976 : 116]*

> *"The "word physical" is there to deal with two little problems.First, one wants to emphasize that a symbol system is a* physically realizable system. *Second, one wants to be sure, one sees its source, i.e.. if it happened that the notion of symbol systems turn out to be an adequate notion for the kind of symbolic activity that we see in humans, that's an empirical* discovery.*(Newell, 1986 : 33)*

In other words, these symbols are instantiated in a token fashion in some physical and material carrier in a computer ; and the carrier is of the electrical type. Thus these symbols are in some location at some time and can be manipulated or processed.

Correlative to this definition of symbols are two important properties of symbols: their *type* and their *atomicity*. Indeed each symbols in this system is considered to be of one type (the category of a sign) -- that is to say, each one belongs to a specific class and each manifestation is a specific token of a type of symbol. A symbol is said to identical with another if it belongs to the same type. Thus each symbol is always part of class. For example, in the following sequence of symbols ## the first symbol # is said to be identical to the second one # not because it is physically the same which evidently it is not but because it belongs to the same type or class. Each symbol can be part of a same category under a description. In other words, the identity relation is not based on physical entities themselves but on their types or category.

Correlative also to this criterion of identity, each symbol is considered atomic and hence without internal structure. These two properties of symbols allow them to be thought of as basic elements for more complex construction (called expressions)built up from a set of simple or combined operations. These symbols are also physical constructions. They constitute larger construction which,in turn can be considered in their type and their atomicity for more and more complex symbols which are always nonetheless said to be of a physical nature.

Sub-thesis : The Nature of the Processing of Symbols.

The second sub-thesis pertains to the processing of these symbols for the building of more complex ones.

> *'Besides these structures, the system also contains a collection of processes that operate on expressions to produce other expressions: processes of creation modification reproduction and destruction. A physical symbol system is a machine that produces through time an evolving collection of symbol structures. Such a system exist in a world of objects wider than just these symbolic expressions themselves. [Newell,* 1976:*116]*

The question that naturally arises from this affirmation concerns the nature of the operations that allow the system to build these more complex symbols called 'expressions' in a compositional manner. For this compositionality principle is based on operations that can have as arguments simple or complex entities that can be transformed in a systematic and finite manner into more simple or more complex entities. Or to use another vocabulary, in" a computational manner". Indeed the process that "manipulates" symbols does this in a very special sense for it does not "handle" the symbols in a physiological manner the symbols but it applies a computational process on them. It is a functional process and this brings up directly the question of computationality. However as we knows this is a very touchy issue in 'computer science'. Indeed what is the application of an operation on symbols and why do we call this application a computational process? Is such a "manipulation" really a physical process? Does the computer really manipulate symbols or signs as a chess player manipulates symbolic tokens on a board? Newell's vocabulary regarding these questions is not very clear. And the metaphors of *construction, destruction, reproduction* and the like as well as the ones more frequently used to explain the physical thesis of the manipulation of symbols are not the easiest to understand. However, surely, Newell knows how such a computation or calculus of symbols, is formally defined in terms of effectively recursive function and Turing machines. Unfortunately, however one is left with the presentation of the underlying computation of physical symbols in metaphorical terms. A computational process seems to demand a quite a construction site!.

Pylyshyn, reflecting on the same subject put forward precisions which in our opinion more accurately relates computation theory to the symbolic process involved.

Computation Theory and Symbolic Processing.

Pylyshyn (1984) reminds us that computation is not primarily a physical process or, in other words a manipulating and production operation that pertains to the physical nature of the computer which carries out the processing. One has to remember that computation theory in its origins was primarily applied to abstract numerical entities, even though one always had to manipulate concretely token of numerals. In fact, computation theory was identified with the problem decidability in number systems. In French, computation was termed "calculabilité". In other words, computationality, even in its origin, was not a thesis about physical numerical symbols and the physical processing of these numerical symbol but a thesis about the abstract properties of objects (numbers) whose ontological status was surely not of the material kind (be it in a realist or platonic tradition) For numerical symbols (digits etc.)may be material marks on paper but numbers are still today abstract objects. This thesis has in fact was changed quite radically. It has now become much more a thesis about the generation,and the transformation of formal symbolic systems. Pylyshyn defines it in the following manner:

> *"the rule governed transformation of formal expression viewed as interpreted symbolic codes"[Pylyshyn, 1984: 70]*

The Newell, at least in its metaphoric presentation, is transformed into a more abstract thesis by such a definition.The processing that is applied to the symbols are not primarily physical but functional. In fact, Pylyshyn conceives computation as a function that takes as input not objects but symbols representing a certain reality. Operations on these pure and uninterpreted symbols can be applied effectively and in a finite manner so as to generate new transformed symbols. Computation is here still thought of as "manipulating " symbols but this manipulation does not operate on physical and material symbols but on symbols sharing a common abstract type property.

In order to understand the difference in perspective, let us take the following example. Here is sequence of symbols {1,0,1}.Now imagine that these numerical digits are each on a piece of paper laid sequentially on a table. The rule of the computational game is as follows : Move the "0' at the end of the sequence, so as to produce {1,1,0}.

Here two machines can be called upon. The first one can be a physical machine (child, robot, lifter etc) that will effectively manipulate physical token symbol according to the rule. This "machine indeed "manipulates " physical symbols. It will move the paper having a "0" written on it to the end of the sequence. The second "machine" will be the algorithm by which the set rule can be effectively applied. Here the operations are thought of abstractly. That is, the rule itself is decomposed in all its implicit sub-operations which are then put into a temporal and logical order. Once this "machinery " has been designed abstractly, any physical machine can realize it.

In our view, it is this second 'manipulating "symbols machine, and not the first one, that exemplifies what computationality is about. Both "machines" can be said to "manipulate" symbols but in two completely different senses. In the second machine, itself implanted in a concrete machine, one can believe that physical symbols are indeed being manipulated because at the end of the process, papers have been moved on the table. However, a deeper analysis will show that this machine is formal and abstract. In fact, the rules and operations which this machine is designed to carry out, do not "work" on the tokens themselves but on "types"of these symbols. The rule does not say, for instance "move the *paper* with a O on it". But " move a symbol of the type O". The token has first to belong to a type and has to be recognized as such before the rule can be applied.

Such a situation exists in the game of chess. The rule that defines the allowed movement of the queen does not say "move a particular physical queen belonging to my personal set. The rule is abstract. As roof: if I lose the queen of my personal game,I can replace it with a shirt button and still play the game according to the rule.

Sub-thesis: 3 The Interpretation of the Symbols.

One of the most frequent interpretation of Newell's thesis (Searle, 1980, Hofstader 1983) is that artificial intelligence presents only a syntactic theory for processing symbols. There is no semantic involved. This is true if one has only an autonomous theory of syntax; but it is not clear if such a theory is what is claimed by the AI theory. On the contrary, there seems to be in AI unanimous claim for the intimate relation between semantic and syntax. However, this is also true in many formal systems; the syntax of many systems is often highly dependent upon the models on which the system is to be applied. Rules of inference, meaning postulate, relations among predicates, and axioms are often only pertinent if related to the semantic the system is to receive. This is particularly true for AI symbol processing. Indeed, if, in a particular system, a material object is to be described as a symbol,it is implied that somewhere or somehow it must receive an interpretation. Not just any object is a symbol. For something to be a symbol necessarily implies that is must either "have a meaning", "refer to something","stand for something else" or "represents something". Any serious theory of symbols relies on an implicit semiotic theory in the classical sense : " Aliquid stat pro aliquo."(St Augustin) or "They stand for Something" else (Peirce). Even for Newell, this thesis stands out clearly:

> *"The most fundamental concept for a symbol is that which gives symbols their symbolic characters, i.e. which lets them stand for some entity. We call this concepts* designation *though we might have used any of several other terms, i.e,.* reference, denotation naming standing for, aboutness, or even symbolization or meaning.
> *[Newell, 1980 : :156.]*

> *There is the notion that symbols actually have symbolic character, What this means is that symbols give access to what they designate."(Newell, 1986 : 34)*

> *Representation is simply another term to refer to a structure that designates. [Newell,1980 :176]*

What is interesting in a symbolic system is not first and foremost the manipulation of the symbols according to various rules. A symbolic system is only interesting or useful if the symbols can be "manipulated" in b relation to a a specific domain of interpretation.

In an artificial symbolic system, the number of combinations and transformations is often restricted. However, this restriction does not depend on the physical dimension of the symbol or the processing machine. One must remember that a syntax theory always defines a specific subset of all possible combinations of the primary symbols. Of all these subsets however, only a small number are assertable for any given use of the system. It is precisely in the choice of operations, combinations, and transformations pertinent to a particular system that the semantic comes in to play. In other words, wether or not a particular combination or transformation is pertinent will depend upon to which objects these symbols are applied. And here one must not mix truth condition and assertability condition. One can understand the sentence "John is a flying elephant" : even if one may not assert that "John is a flying elephant.

To understand this point, let us examine the following example.

Given the set of digit 1...N, we shall define the following rules:

1-The set SYMBOL is {1..N}
2-A DIGIT is one of the elements of this set, i.e. X is in SYMBOL
3-or a DIGIT is the result of an operation on some DIGIT s :
for instance DIGIT * DIGIT= DIGIT
where * is a sign of an operation.

These rules generate the following possible digits

1*2-> 12
4*8-> 48
12*48-> 1248 etc

One can imagine adding many more operation such as the + operation

1+4->5
2+7->9
etc.

However, if one asks the question of which sequence of digit produced is pertinent, useful, true etc of all those generated by the operations, no answer can be given without semantics, that is without knowing what these symbols mean, refer to etc. The first set of operations can produce results which are true as the second. All depends on the domain of objects to which the symbols are to be applied. For instance, the first operation can be pertinent if applied to social security numbers. Here the operation * is understood as simple concatenation of numbers. However these sequence of digits are absolutely useless of false if they refer to the set on natural numbers ;in this case * would have to be interpreted as a multiplication sign. Let us now imagine that the domain of application is the set of natural numbers; then the operation + effectively defines the relation of addition on theses numbers. However in this case the * operation could not be understood as defining the multiplication operation.

If we have dwelt on this example, it is to show more precisely where the issue of computational interpretation of symbols arises. Even though the Newell and Simon formulation seems to say that an artificial intelligence system "manipulate" physical symbols without reference to semantics, one must see that this "manipulation " is essentially controlled by an implicit semantic. This is because artificial intelligence always has a domain of application ; the *choice* of the rules is always constrained by an implicit or explicit interpretation. It is true that it is the rules that render a manipulation legal or illegal i.e.it is the rules that allows a specific configuration of symbols to be acceptable or not from a syntactic point of view, but these manipulations are allowed because they are correlated to a semantic interpretation, be it explicit or implicit. The manipulation always aims to produce interpretable configurations of symbols. The system is always constrained by the meaning of the symbol it manipulates. Artificial intelligence system are not pure movers of uninterpretable symbols! Pylyshyn defines in fact computationality in terms of the interpretation involved:

> *'A computational process is one whose behavior is viewed as depending on the representational or semantic content of its states. This occurs by virtue of there being another level of structure- variously called the 'symbol level 'of the syntax or logical form - which possesses the following two essential properties. One, the formal syntactic structure of particular occurrences (tokens) of symbolic expressions corresponding to real physical differences in the system, differences that affect the relevant features of the systems behavior. Two, the formal symbol structures mirror all relevant semantic distinctions to which the system is supposed to respond and continue to do so when certain semantically interpreted rules are applied to them, transforming them into new symbol structures."*
> *[Pylyshyn 1984 74.]*

Haugeland [1986:106] maintains the same thing when he defines a computer as 'an interpreted automatic system that is to say a symbol-manipulating machine "

Thus this third sub-thesis brings us directly to the heart of semiotics. A computational system is one which manipulates symbols that are interpretable symbols. Naturally the question of the intelligence of the manipulation remains, for it is not because a system manipulates symbols in an automatic fashion that a system simulating intelligent behavior exhibiting all the properties of the intelligent higher living organism. such as intentionality, conscience, mental representation is achieved. The most simple calculator carries out computations. It manipulates symbols interpretable in a number theoretic manner but no one regards the calculator as exhibiting intelligent behavior.

Still, although the manipulation of interpretable symbols may not be a sufficient condition, is still a necessary condition for any intelligent behavior.There is no intelligent behavior without this semiotic process :

> *"At the root of intelligence are symbols, with their denotative power and their susceptibility to manipulation. And symbols can be manufactured of almost anything that can be arranged and patterned and combined. Intelligence is mind implemented by a patternable king of matter,*
> *[Simon, 1980: 35]*

This manipulation of interpretable symbols is even given as a sufficient and necessary condition.

> *"A Physical symbol system has the necessary and sufficient means for general intelligent action "*
> *[Newell, 1976:16]*

IA Symbol and Representation

What is the interpretation to be given to these symbols that are " manipulated " by a computer in an AI system. The answer her seems to be related to the representational function these symbols play in the processing system. According to Haugeland (1986: 28) they represent something of the outside world or to Newell and Simon (1976) an intern process of some kind by which some action is undertaken. And indeed one must remember that the processing of an "object", a "problem", or an "event", the moving "of a mechanical arm", a "pawn " on a chess board, the understanding of a sentence, the analysis of a molecule, if produced by a computer, are all said to be prototypical of artificial intelligence if first,these objects are not processed for themselves, that is in their basic materiality, but under a symbolic representation of one type and second, if the manipulation of the elements of this representation, that is to say the production, the recognition or the transformation of these symbolic elements, is controlled in some way by rules specific to the system used to represent these "objects". For instance the Winograd SHDRLU system(1972), does not manipulate "physical red bloc" or even "robot arms.' What is "manipulated" is always a set of symbols that represents them. When MYCYN (Szolovits and Pauker 1978) carries out a diagnosis,it does not analyze real symptoms but their representation. Thus, the various atomic or complex expressions of these symbolic systems are to be understood as representation of some object or process.

However this question of representation or more specifically the symbolic representation is today a delicate one. Many contemporary projects in cognitive psychology, AI and in neurophysiology hesitate talking about intelligent behavior in terms of symbolic representation. The works of Freeman and Skarda (1987) for instance openly refuse to call upon a theory of symbolic representation or even of any kind of representation to explain intelligent behavior. An auto-regulated neurological system that processes massive amounts of information in a parallel fashion does not seem to rely upon any representation. By extension, any valid theory of artificial intelligence according to this perspective should abandon the paradigm of representation no matter what form it takes.

Some, as Rumelhart et al. (1987), Smolensky, (1988)although they agree to talk of representation refuse to discuss the question in terms of symbols. For them,representation is understood in terms of information. Which in our opinion does not really solve the problem. Indeed this concept of information, although it seems highly material and empirical, is still in its many uses, an unanalyzed concept and it subtly reintroduces the question of what classically the question of *natural sign*, *symbol* and *representation*. For any object event though it may intrinsically carry information only become efficient when it is interpreted. Even an neurotransmitter that can carry information from one axone to another axone, has to be " detected " or as, it is said in the literature,"interpreted". It is not just any kind of acid that excites a neuron. One should not here confuse the carrier of information with the activity a receiving agent applies to this information itself. Drestke(1984, 88) has shown how the concept of information implies a theory of natural sign.

However, all this is a highly debatable question, and, for the moment, one has to recognize that in classical AI projects and theories, the symbolic representational thesis is of the utmost importance. The fact that these representations take either a procedural form, or a propositional-declarative, matrix,topological, etc., form does not change their representational status. For a representation is by nature a representation of something other than itself. A status which is precisely that a semiotic nature. "aliquid stat pro aliquo". Each representation is always controlled in its form and in its interpretation.

Whether seen from the classical linear or the parallel point of view which is said not to be representative but informational, the question of artificial intelligence always calls upon an implicit theory of interpretation. An this is precisely the bridge with the semiotic paradigm : how can an object, material as it is can refer to something else than itself or in more classical terms, be "aliquid stat pro aliquo', that is to say, a sign?

- Artificial Intelligence and Semiotics.

AI projects seem so much attached to computer technology that we tend to forget that its real originality lies in the complex semiotics system that it puts to work.For AI is in fact an applied semiotic. Its studies the functioning of a type of sign called symbols in a constructed or artificial system that is interpretable in cognitive terms.

Certain recent applications in information sciences and expert systems demonstrates that AI is directly related to semiotics. For instance, projects in information science are regarded more and more as processing of signs so much so that Taranto (1980) and his colleagues define their activities as semiotic research.

For instance, certain expert systems of text processing and understanding are very close to the concrete practice of(except for the computer simulation part) semiotical analysis of text. The works of Schank and Abelson (1977), go back to the origin of the formal semiologies such as Propp and the Prague school of linguistics. It is not surprising to see how close Winograd's(1972) programs are related to Halliday's (1984)semiotic program of text functioning. Recent expert systems such as MYCIN imply strict semiotic theories. One should recall the sixteen century semiotics of Gallien medical diagnostic processing.

This issue is even more evident when one analyses peripheral problems such as conceptual structures, knowledge representation, inference mechanism etc. It is not because a certain domain research is most often studied by particular professionals having a specific technological training (e.g. computer scientists) that the epistemological status of a domain is changed. If this were so, one would have to eliminate from AI projects problems of linguistics, logic, hermeneutics, cognition, linguistics, anthropology, philosophy for they are not domains that are classically present in the training and the work of the computer specialist. One cannot indeed refuse to see that although certains discipline operate in relatively deliminated paradigms, one cannot find at work some metatheory of sign and interpretation. For instance even if one is working in logic and one defines a proposition such (PA & Qa->Qa) as true does not eliminate the semiotic problem. On the contrary, it presupposes it here is not a logical theory that does not rely on an implicit theory of symbols and their interpretation. This is the reason why, from Locke to Peirce semiotics was identified with logic.

> *"The third branch (of logic) may be called SEMIOTIKN, or the doctrine of signs; the most usual whereof, is to consider the Nature of Sign, the Mind makes use of for the understanding of Things, or conveying its knowledge of others,*
> *John Locke, 'Of the division of the Sciences. '1690.*

This thesis was in further developed by Morris (1938) who divided semiotics into syntax, semantic and pragmatic.

Unfortunately, some theoreticians of AI do not accept the integration of their work into semiotics.Their understanding of what constitutes semiotic is often restricted to specific applied semiotics or constrained semiotic practices which are often very limited and empirically difficult to study. This is the case for instance of Pylyshyn (1984) who thinks that semiotics is only interested in secondary symbols i.e. symbols that humans use for communicating meaning:

> *"These are not symbols that functions directly as intrinsic causes of behavior 'the way symbols do in computers.* The symbols of semiotician have no meanings *and exhibits no behavior unless there is an intelligent knowing agent to interpret them.'*
> *[Pylyshyn ;1984:118]*

It appears that for him, these symbols do not have meaning and apply only to cultural social, and conventional, and even personal symbols. Semiotics seems to be identified with ideology and social discourse.

> *"Hence to study these secondary symbols is to study the body of cultural conventions, intention, aspiration and so on, of individuals and groups. By contrast, mental symbols of the sort that concern cognitive science, like computational symbols, have intrinsic meaning(semantic) by virtue of being instantiated in a physical mechanism in such a way that they interact causally with each other and the world outside (though transducers) Pylyshyn, 1983: 118.*

It is evident that Pylyshyn here identifies semiotics with some particular semiotic practices And it is not not because a particular discipline is interested in some specific type of sign for instance such as linguistics and logic, that it is not within the domain of semiotics.For in the general theory of semiotics there are various types of signs each one operating in one or many various types of semiotics systems. Symbolic systems are but one type of semiotic system.

When talking about symbols Ai seems to be refering to univocal symbols constrained by formation and transformation rules, that is a system of symbols that Peirce called deci-sign in contrast to conventional and socially regulated sign(said to be the specific objet of semiotics for Pylyshyn) called by Peirce legi-sign. But, if one analyses more strictly AI's concept of symbol, one would probably, in a percian tradition call them something like a crossing of Icons and Indexes. *Icons* because IA sees the indication relationship inscribed in the physical structure of a symbol and *Indexes* because there exist something like a causal relation between the symbol and what they designate.

> *“If you say that symbols designate X (whatever X is), then in fact what you see in the physical structure of that system is an access relationship.“(Newell, 1986 : 34)*

> *“If one is given the symbol token, then a physical access relationship allows one to get access to information about it. Newell, 1986 : 34)*

This problem show how AI operate with deep and classical semiotic concepts. And,at this point it is interesting to recall some classic definition of what semiotics is: For Morris, semiotics is essentially a metatheory about signs:

> *"It is a language about signs" [Morris, 1938:23]*

For Sebeok, it has a communicative dimension:

> *"semiotics... can be informally defined as science that studies all possible varieties of signs, and the rules governing their generation and production, transmission and exchange, reception and interpretation. Concisely put, semiotics has two complementary and interdependent aspects: communication and signification"*
> *[Sebeok: 1976: 23].*

Some may believe that Sebeok's definition lacks formality, however it should be remembered that at least for Peirce and for many contemporary semioticians, semiotics is essentially a formal science of signs a which calls upon theories of communication, interpretation, cognition and meaning. We should not be surprised that even in its most formal development, logic, such as developed by Russell, Tarski, Montaguë, Church, Quine, etc. and applied to the domain of proposition and inference, once one as passed the question of proof and inference, one is immediately confronted to problems of semiotics. Be it the problems related to cognition, (epistemic and modal logic), communication (belief logics), interpretation or pragmatics. For Morris,the sign classification in terms of syntax, semantic and pragmatic, is above all a characterization of all forms of codes and not only of those codes which pertain to natural or artificial language, these constituting but one type of sign system. Medieval philosophers such as Poinsot, used to preface their Logic Treatise by an long semiotic introduction.

The Semiotics of Symbols.

It is thus clear for us that in the various theories of AI, one has to postulate an implicit theory of semiotics that contains syntactic, semantic and pragmatic dimensions. A system that processes signs, or as it is said in the discipline "symbols", contains at the least rules that generate, transform and interpret these signs or symbols. The question of syntax is often obvious however its status with regard to semantics, is often a a matter strong debate. Classical AI theories always assert a semantic dimension for their symbols. But this semantic as often underlined is not is not the best understood thing. The thesis that symbols are instantiated in a material carrier and that this carrier embeds the referring, denoting or indicating relation does non constitute the clearest of semantic thesis. One also encounters in these systems a pragmatic question. Moving about a red block in SHRDLU is response to an order given by a user in a communication situation. This behavior is manifested by an adequate manipulation of symbols that are syntactically well structured and semantically interpreted. Hence with these syntactic, semantic and pragmatic question, one can not have a more semiotic system.

In semiotic theory, a symbol is but a particular case of sign. And the sign is classically the name given to one of the constituents of a complex process called semiosis (Peirce). Here the definition of sign is essentially dynamical. This semiosis process is composed of the interrelations of many elements. At one end there is usually a material object or event (gesture, act, mark,etc) which for an agent (some human, animal, mechanical, biological organism) is an input for interpretation. Thus, this interpretative agent recognizes the object or event as related to something else reacts to them as carrier of information.

An object is not a sign or a symbol because it is an object. To be a sign always implies a process by which this object is put in some relation with something else. In opposition to the logical definition of interpretation that only sees this relation as a formal function between expression in a language and objects in a world, or in opposition to recent theories of information (Drestke, 1982) that analyses the indication or denoting relation bewteen a sign and what it designates as either causal of probabilistic, the semiotic interpretation is here thought of as an intervention or action of an agent on these signs or symbols. The semiotic interpretation is thus not only a relation but a process (cognitive or computational) carried out by an agent that goes from some object (signs) to some other objects (its reference /denotation /meaning) etc. It is the former object or event that is commonly called sign or symbol. It is precisely a sign because it is not taken for itself but stands for something else as established in the interpretive process. This is why, that it can be said, according to the semiotic perspective, that a redness on a skin, a light on an instrument panel,an uttered word, a gesture, a flag, a dance, are all "signs". They may be objects in themselves, but if they are taken as signs they become objects that stands for something else. Calling these objects themselves "signs" poses no great problems in daily conversation but can become highly problematic if used without nuance in a more analytic and scientific discourse.

As a final point, the agent that realizes the interpretation, does this act according to his/her/its constitutive nature. If the agent is a human organism,the interpretation will take a cognitive aspect and will probably present a higher level of processing and call upon upon some type or other of representation. An animal, on the other hand, will probably behave differently. Both of them however, if put in front of some same signifying event (such as smoke in a forest), although they would process the event differently, would probably give it a similar meaning (such as it being as sign of fire or danger), even though the representation of this meaning would not be embedded in the same manner in both organisms. This internal modality by which a sign is processed differently by different organisms constitutes precisely what Peirce called the problem of the interpretans. In more contemporary and technical terms, this problem overlays what is called the knowledge representation problem i.e. the modality by which organism interprets and holds onto the meaning of his past present and future signs. In other words, any object or event that enter in the semiosis process and becomes a sign is always presented to an interpretative agent as a structured sign and has to be interpretated accordingly. Be it in a saussurian, peircian, morissian or fregean theory of signs to name only a few, one always encounter an object that serves as carrier of the sign function, a *mode of presentation* by which the sign stands for something else, and a *correlate* that serves as meaning for this sign. These three constituents,i.e. the *carrier* of a sign, the *indication* relation and the *correlate*, are quite classical ones in the various semiotic theories, But often they are not always recognized as such and are often treated very differently. For instance,in a Tarsky -Montaguë paradigm the correlate of a sign will be treated in an extensional fashion. For others,the mode of presentation of the sign relation may be embedded in a highly symbolic if not propositional manner such as it is proposes in some recents cognitive psychology theories (Fodor,1983 Johnson Laird, 1983,1988). And all these problems are of a highly theoretical nature. To illustrate this for the the purposes of this comparative study of artificial intelligence and semiotic,let us dwell briefly on the first constituent of the semiotic relation that is what is called the carrier of a sign or of a symbol.

All serious semiotics must distinguish in a sign between the *carrier* dimension of a sign and a *semiotic feature* of the sign. A carrier is always a physical object or event(simple or complex) which by reason of some of its physical properties can possibly be invested by some agent (machine, animal of human etc) with an interpretation. Indeed, in what is commonly called a signal, a sign or a symbol, one must distinguish in the object properties of the object and properties that are semiotically pertinent. We can call the "carrier" of a sign that which serves as physical support for a sign, and the *characters or features* of a sign that, which in the terms of Hjemslev (1943) are the properties of the object that can be semiotically revealing for an interpreter or an agent. A character of an object is a feature of an object that for an interpreter (mechanical or cognitive), is "detectable" or "recognizable"as semiotically pertinent (either because it carries by itself information (natural sign) or because of a convention(non natural-sign). A semiotic feature or character is not an absolute property of an object but a relational one, i.e. that is, what is in the object used as the carrier of a sign which carries information naturally or by convention and is interpretable by an interpreter. Only a character and not the carrier is the input for a semiotic process.

To understand this distinction, let us take the example of an object that is used in a semiotic process : a coin. A coin is a physical object But it is a sign only under certain condition. It is not all the properties of a coin that constitute the input for a semiotic process. Only some specific properties constitute the input of the interpretation process and these properties are so relative a specific agent. For instance, in the case of a parking meter, only the ROUNDNESS, HEIGHT and WITDTH are pertinent features, that is the meter can "interpret " only a physical carrier with these characters. For a public telephone the WEIGHT character has to be added. For a human interpreter, many other characters have to be present in order for him or her to recognize it as a sign of something else. For each type of interpretative agent only a specific set of character are pertinent features. The carrier could indeed be any physical object whatsoever, it will be acceptable to the agent if and only if it presents these characters. So the carrier is not by itself a sign. The real focus of a sign is this "conglomerate" of characters that are for a specific agent semiotically pertinent. It is for this reason that any physical object presenting these characters can, for this agent, be recognized as a sign. A meter will indeed "accept 'all carriers that present a specific HEIGHT, WIDTH and ROUNDNESS.

Let us now come back to our physical symbol of our AI systems. We can think that what an intelligent system manipulates are not strictly speaking "physical" objects or symbols.

> *"It doesn't make any difference at all what kind of physical characteristics you're talking about, except that you can distinguish some patterns, some parameters of the physical world." (Newell, 1986 : 33)*
>
> *" There are also expressions.I could have use the term "symbol structure" to mean the same thing.An expression is simply a domain in that medium.It take up space and time, and it contains instance of these symbols which we can call tokens....So an expression is a little chunk of that medium that actually holds the symbols. The symbols are just patterns, but the expressions really take up space and time and have weight(if you want to think about it that way) The medium is also arbitrarily larger- that is the usual requirement of an unbounded memory."(Newell, 1986 : 33)*

In fact, the system does not "moves"objects around physically. The computer does not heat up because physical symbols are being manipulated very fast and touch the the side board of the computer! What a electronical process reacts to are the the specific characters and patterns of a set of physical carriers. Even the word "manipulate" is ambiguous here. It resemble the proposition that says that a mathematician manipulates numeral or inks marks on a paper. A mathematician does not "work" on numerical digits but on numbers that are instanciated as ink marks if and only if these ink marks have a certain set of structured characters.

According to this view of things, a symbol is also a sign and as with any other sign, has a carrier. However, to say that it is instantiated in a carrier does not really clarify the issue. For only some of the properties of the carrier can be the input for a process of interpretation.

If this is the case, what then in a sign-signal theory is the status of a symbol? According to a semiotic perspective, it is not the carriers that are at the heart of a sign. The physicality of a symbol can not be its denotation or its meaning although it could be trough this physicality that this denotation could be found. What a machine or an organism 'manipulates" is a the structured set of relevant features of this carrier and not the carriers themselves. It is only the characters that can be reconfigurated, transformed, changed, deleted and so on. Always however they will have at each step of the process a carrier to sustain them.

Semiotic theories and applied semiotics studies, each one according to its proper conceptuality and paradigm aim to describe some of the characters of complex systems. A sequence forming a sentence has a set of structural characters highly different from a text, a gesture, a dance, or a ritual etc. Exhibiting these characters and their internal structure is not easily done. When an anthropologist exhibits the conceptual structure of a legend, he or she lays upon this legend an hypothesis of its functioning. There is not much difference there with what an AI specialist does when he or she offers a descriptive structures of the relevant features a restaurant story or of a simple object to be " seen" by a robot.

Maybe that the computer implementation of this frame structure gives greater validity to the hypothesis but maybe too, the interpretation of the anthropologist attains a much higher level of consistency and exhaustivity in explaining the meaning of the story. A native American legend about a tribe eating a salmon in festive ritual will probably receive a sightly different interpretation if it is given by Levi-Straus than if it is given by Schank. Be they superficial or profound, both are interpretations and as such are a semiotic enterprises. Here completeness consistency and functionality are confronted.

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