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Article

An Approach to Conceptualisation and Semantic Knowledge: Some Preliminary Observations

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Abstract: The paper below takes up the question of whether it is possible to transfer the notion of 'semantic knowledge'—as a human process of making language generate and confer meanings—to machines, which have as one of their properties the capability of handling high amounts of information. This issue is presented in an extended introduction to the paper's account of and solutions to this intricate problem. Thereafter, the theoretical notion of 'knowledge' is considered in its philosophical, and thereby scientific, context, and the basis of its modern import is pointed to being Immanuel Kant's deliberations on a priori vs. a posteriori knowledge. The author's solution to the predicament of modern ideas about knowledge is the proposed theory of Occurrence Logic, invented by the author, which abandons truth-values from valid reasoning, and this approach is briefly accounted for. It presupposes a theoretical model of human cognitive systems, and the author has such a model under development which, in the future, may be able to solve the question of what 'semantic knowledge' actually is. So far, the theoretical account in this paper points to the critical issue of whether natural language semantics can be grasped as words explaining words or must include the connection between words and objects in the world. The author is in favour of the last option. This leads to the question of the functions of the human brain as the organ connecting words with the outer world. The idea of the so-called 'predictive brain' is referred to as a possible solution to the brain/cognition issue, and the paper concludes with a suggestion that an emulation of the interaction between the mentioned cognitive systems may cast some new light on the field of Artificial Intelligence.

Keywords: 'semantic knowledge'; occurrence logic; truth-values; theoretical model; cognitive systems

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1. An Extended Introduction

The topic of this paper is the theoretical notion 'semantic knowledge' in the context of 'artificial intelligence'. It may be seen as quite ironical that the paper deals with the meanings (the semantics) of words, thereby using the meanings of words to explicate theories about the meanings of words. This illustrates two things: first, this is the normal way of working with word meanings, using words to talk about other words, at least when they have been alphabetised; second, it is a general issue in 'handling the world with words', for instance ending up with the Tarskian dichotomy between *meta language* and *object language*. In this context I will try to expose the complexity of the problem. Since the label 'artificial intelligence' refers to software developed for special problem-solving purposes, it is taken for granted that what is understood as 'natural intelligence' in humans can be 'mimicked' by machines, some way or other. Thus, it seems to follow that for machines to do so they will have to 'understand' linguistic descriptions of the problems that need to be solved; furthermore, assuming that the meanings, the semantics, of the linguistic descriptions should, somehow, possibly be 'grasped' by the software in the form of 'knowledge'. By doing these things, the software in a machine can be said to 'emulate' the intelligent processes of the human brain.

Thus far, this seems fair enough; however, there is a caveat. Taking the words mentioned above in the order they are introduced, it should be noticed that the word 'semantic(s)' does (ironically) not have a clear-cut meaning. As is well known, the word was proposed by Michel Bréal in 1883 as a French word: *sémantique*, and since then the theoretical concept has been central to people in the 'language sciences', i.e., on the one hand, philologists and linguists working on the meanings of words, and, on the other hand, philosophers trying to describe and explain the (primarily logical) mechanism of linguistic meaning and the meanings of what is called sentences. One could say that the Western philosophical tradition of contemplating word meanings goes back to Classical Greece, i.e., about 2.5 millennia, whereas European lexicographers have worked systematically on setting up word definitions since the Middle Ages. A modern overview of linguistic semantics is [1]. One may observe that it is, in two volumes, only a survey of the, by then, accepted approaches to the topic in the second half of the 20th century. There is currently no 'basic semantics' theory on the market, so, accordingly, *we know **that** linguistic meaning works*. If I talk with my wife about her dog, responding to the name Shirlock, and I say that »Shirlock is sleeping on the sofa« we both know for certain what entity we are talking about; and, consequently, there is a relation between the word *dog* and *Shirlock* lying on the sofa. Although, *we do not know **how** linguistic meaning works*, i.e., the nature of the relation. Neither do we know *what linguistic meaning **is***. Of course you may hold the view that it is not so important, in the vernacular: 'It's a bit like' not knowing what gravity is as long as we know that our feet will stick to Earth. The state of affairs is not better concerning the word 'knowledge'. In the tradition of epistemology it is customary to say that 'knowledge' is 'justified true belief', but numerous tractates on each of the words in this definition have been written; which is why one may, without reservations, profess that these words have no undisputed meanings. Moreover, as long as we do not know what the noun of the predicate, 'belief', means we are no better off. So, we can be sure *that* we are able to know things for certain; but, we neither know *how* we do it, nor *what it is*. Is that a problem? Yes, if we embark on a project trying to have a machine emulate 'semantic knowledge'.

It gets even worse when we ponder over the meanings of the words 'artificial intelligence'. It is commonly acknowledged that *intelligence* is actually two different words with separate meanings: (1) information in a political or military context; (2) the human ability to solve problems. In meaning (2) it might be more suitable to use the term *capability* (meaning 'ability to do something') instead of *ability*, but the crux is that today the expression is often associated with the abbreviation IQ, 'intelligence quotient'. Not everybody knows that the idea of IQ has a bizarre origin, see [2], and to the extent that 'artificial intelligence' is conceptually linked to the notion of IQ it will be difficult to implement it in software. However, ignoring that relation we must acknowledge that we do not know *what* intelligence *is* in humans, we do not know *how* it works, and, finally, we cannot say with confidence that we know *that* it works. Therefore, an endeavour to implement a nebulous piece of matter such as this may, accordingly, look like a hazardous undertaking. As can be seen in the following, some qualifications may lower the risks.

In the following sections, the paper will contemplate the notions of 'knowledge', 'semantics', 'conceptualiation', 'intelligence', and 'artificial', almost in that order. Especially in connection with 'knowledge', it is important to consider the epistemological alternatives and the associated formal logical framework. As for 'semantics', there is the fundamental question of whether words 'have semantics' (mean anything) in isolation external to their use in sentences and other contexts. The paper will conclude by reflecting on the question of whether 'artificial intelligence' is actually human intelligence processed by a non-human system, or whether it is just a label attached to certain kinds of electronic systems:

> At the very beginning of the computer age, scientist were struck by the parallels between these new machines and brains and were inspired to use them in different ways. Some ignored biology and focused simply on making them as smart as possible, a field known as artificial intelligence (AI—the term was coined by John McCarthy in 1956). Ref. [3]

The expression *smart* presumably implies that it has to do with offering solutions to problems or with carrying out an intellectual piece of work, for instance making complicated computations.

2. On Knowledge

The question about how the human mind is able to know things about the world goes, in Western Culture, back to at least Classical Greece (see [4]), and the foundation of the modern version of what is in philosophy called 'epistemology' was laid by the so-called English language empiricists John Locke, George Berkeley, and David Hume in the 17th and 18th centuries. Their question can be boiled down to whether one knows, by means of perception, the nature of things outside one's body—i.e., one's brain or mind—or one is only able to know the outcome of one's perceptions, viz. mental phenomena? One answer, previous to the deliberations of the figures mentioned, was proposed by René Descartes in his famous formulation (originally in the French publication *Discours de la méthode* . . . 1637): *cogito, ergo sum* 'I think, therefore I am' (see [5]) by which he indicated that he knew that he existed, and therefore that he knew something about the world. That things are not quite that easy can be seen from the thoughts of the three British philosophers. I shall not go into these historical concerns, only let my line of reasoning take another direction, having the Western philosophical tradition as a frame of understanding.

However, first an obiter dictum: I once asked my linguistics students what was inside the laptops almost all of them had opened in front of them in the auditorium. The almost unison answer was: 'information!'. I asked how they knew that, and their answer was that they used the laptops as sources of information, and that information must, therefore, be inside their computational marvels. I then pointed to the fact that the only non-hardware in their machines was low voltage oscillating electric currents To what extent the amount of low voltage currents in a laptop computer is part of the entropy of the universe, and thereby contributes to the accumulation of information (in that sense), is beyond the scope of this paper, but the only way in which the currents had any use was either as (1) affecting other systems, for example in cars where electronic systems interfere with mechanical systems, or as (2) formats of presentation that by humans would be perceived as information, for instance on digital screens. They did not believe me, so they just carried on with their 'communications studies'. Anyway, theirs was a perfect example of a categorial fallacy: because you perceive something as such and such then it may not be what you perceive.Or scientifically, as phrased by the Italian physicist Carlo Rovelli: *Reality Is Not What It Seems*, which is the title of his 2017 popular book on quantum gravity.

Instead, I shall stick to my claim proposed elsewhere that the conclusive answer to the epistemological question was offered by Immanuel Kant, in his [6] *Kritik der Reinen Vernunft*. Kant is one of the most debated philosophers in Western Philosophy and his thoughts are, by no means, easily accessible; however, in this context I will take up the approach to Kant offered by the Canadian philosopher Robert Hanna in a number of volumes and other publications; an approach that takes seriously what he calls 'Kant's doctrine of transcendental idealism' [7] (p. 1). Hanna says that:

> . . . Kant's fundamental philosophical question is effectively equivalent to the question: how are *meanings* possible? In the philosopher's lexicon, 'meanings' are nothing other than object-directed representational contents, taken together with the formal or logical elements contained within such contents. This immediately implies that Kant's fundamental question belongs to the domain of *philosophical semantics*. Ref. [7] (p. 3)

Hanna's larger project is to demonstrate that:

> . . . the analytic tradition *emerged* from Kant's philosophy in the sense that its members were able to define and legitimate their views only by means of an intensive, extended engagement with, and a partial or complete rejection of, the first *Critique*. Ref. [7] (p. 5)

As is well known from the epistemology syllabus, Kant suggested the distinction between different kinds of knowledge (*Erkentniss* 'cognition'), among them two kinds of truths:

> ... necessary a priori truths of reason; and contingent a posteriori truths of fact. Ref. [7] (p. 26)

In my view 'necessary a priori truths of reason' is the only domain where traditional formal (including symbolic) logic applies indisputably. Whether 'contingent a posteriori truths of fact' can be a domain where traditional formal (including symbolic) logic applies unquestionably is a matter of debate, but that is beyond the topic of this paper. What is controversial is Kant's claim that there is a third category, viz., so-called 'synthetic a priori' truths [7] (p. 24) expressed in so-called 'synthetic propositions', as opposed to the 'analytic a priori propositions' [7] (p. 28). The propositions last mentioned are necessarily true and independent of experience, they are 'transcendental' ([7] (p. 1) et passim). 'Contingent a posteriori truths of fact' are, in opposition to this, dependent on experience, they are not 'transcendental'. What Kant now suggests is that there are, as mentioned, 'synthetic a priori' truths, which means that there are truths which are transcendental, i.e., independent from experience, but are about things in the world, i.e., 'synthetic'. This must be said to be counterintuitive! How can we know the truth about things out there without having any experience with them. Kant's line of reasoning is quite convoluted, but one of the important features is the understanding that two of the concepts in human interaction with the world, space, and time, are not entities out there but forms of intuition (*Anschauung*; ([7] (p. 1) et passim). Alternatively, phrased in another way:

> ... synthetic a priori mathematical truths are possible by virtue of their cognitive-semantic dependency on one or another of the two pure subjective forms of intuition, space and time. Ref. [7] (p. 29)

It follows that space and time are transcendental ideas—therefore we have Kant's 'transcendental idealism'—and beyond empirical experience, and because of that we will know for certain that specific—for instance mathematical—statements are true. Not as entailments such as those in analytic a priori statements, but because the pure subjective forms of specific intuitions tell us that they are true. Whether Kant's view is in accordance with 'space–time' in modern physics I am not the one to determine.

This may not be easy to understand, and Hanna's main objective is to demonstrate that the most important school of thought in Anglo-Saxon philosophy, so-called Analytic Philosophy, is one long—according to Hanna unsuccessful—attempt to prove Kant wrong on this. I myself fully agree with Kant, and if inclined to be rude, which I think I am normally not, I might say that after Kant not much has happened in philosophy. I therefore try to find ways of resolving this predicament, viz. Kant and Analytic Philosophy. And this is where what I call *Occurrence Logic* comes in by abandoning truth-values from the idea of knowledge.

I shall come back to this topic below, though before that I would like to offer a few words on my interpretation of Kant's thoughts on so-called a priori knowledge expressed in true synthetic propositions, in short a priori synthetic knowledge. My reading of Kant may be flawed, but I would not accept that it may be incorrect. One of my philosophy teachers in the previous millennium said that (from what I recollect) 'obscure thoughts have many exegetes and sometimes many followers', however, I do not see Kant's thought, as presented in his work, as obscure, only difficult.

Also, his idea that there is synthetic a priori knowledge may be applied to the mathematics of geometry in that one can say that knowledge about, e.g., triangles is such knowledge. Thus, a statement—defining a 'triangle'—such as [8]:

a flat shape that has three straight sides and three angles

is, of course, a priori analytic knowledge because it is the definition of what a triangle is, i.e., the predicate—namely the meanings of the words in the definition (the *definiens*)—is inherent in the meaning of the *definiendum* (the subject of the proposition). However, since you have never encountered a prototypical—a universal exemplar of—a triangle you will have to resort to the features mentioned in the definition. But alas, then you encounter the same problem, viz. that the knowledge about *straight sides* and *three angles* is also a priori analytic knowledge (for the moment ignoring the meaning of the number 'three'). You may, accordingly, be caught in vicious circularity when trying to solve the issue of the foundations of mathematics, later taken up by, for instance, Frege and Russell. One of my colleagues at the Department of Swedish Language at the University of Göteborg once concluded that the task of lexicographers—which is to define all the words in a lexicon of a language—was, on that point, absurd. In my view, Kant offered the solution—albeit that I have to acknowledge that the literature on Kant is huge and furthermore includes a long range of types of work from college essays to voluminous treatises—that knowledge about what a triangles is, is a priori synthetic. This means that when you come across a graphic representation of a triangle then you know it is a triangle because you have the (transcendental) a priori idea of a triangle and you therefore *intuitively know* that this is (*synthetically*) an instance of a triangle. The idea of a triangle may not conform to the definition since one may assume that we are in a curved space—and, empirically, triangulation on the surface of Earth will by definition be impossible—which means that the triangle is not a 'flat shape' but anyhow still is, somehow, a triangle.

There are two reasons why I do not think this is a satisfactory explanation. First, 'intuition' is, to me, not a clear-cut notion because you may intuitively respond physically on the background of intuitions—without thinking—and, to me, knowledge is unbreakably connected to language as the vehicle of thinking. Second, it looks indistinguishable from a posteriori synthetic knowledge. In the proposition »this is a triangle« the subject 'this' refers to whatever you see. It has an indexical (by linguists called deictic) referent, and the predicate is an equivocal description of what you see, i.e., the a posteriori synthetic knowledge, expressed in the statement. The way I see it, the basic worry lies in the interdependence between *knowledge* and *truth-functional propositions*, summed up in the classical, but not uncontroversial, formulation of knowledge as 'true justified belief'. Since the first steps of more or less formal Western Logic, 'justify' has meant 'expressible in propositions', i.e., sentences with *truth values* as being either true or false. If we follow that line of reasoning the subject of a proposition is traditionally assumed to have reference, and accordingly one or more referents. Yet, in the definition of a triangle the word *triangle*, as quoted above, has no referent, it is only an idea in the mind: in the proposition »a triangle is a flat shape that has three straight sides and three angles« the subject has no referent and thus no reference, it is only a word representing an idea. The proposition cannot, therefore, have any truth value. I am not sure what Kant would have done (or has done, I have not read everything written by Kant) with that, but I shall claim that it does not undermine Kant's notion of a priori synthetic theory. On the contrary it undermines *the orthodox concept of knowledge as linked with truth*. Therefore, this is where what I call *Occurrence Logic* comes in.

3. On Occurrence Logic

The overall objective of the approach called *Occurrence Logic* (OccLog) is to abandon truth from the domain of valid reasoning. It is a well known fact that the only kinds of propositions on which their truth value is determinable by certainty are contingent particular (synthetic) statements. Take the statement above that »Shirlock is sleeping on the sofa« and one will, beyond doubt, be able to know if that is true or not. It is a little more difficult with universal claims, apart from a priori knowledge embedded in analytic propositions. Nevertheless in both cases the prerequisite that truth is the basis of logic as valid reasoning makes things more complicated than they would be without the notion of truth. The truth criterion demands that both claims have an empirical justification: is the semantics of the subject in the definition (an a priori analytic proposition) »a dog is . . . « truthfully the correctly identified meaning when checked on the background of the real world? Besides, if Shirlock is really on the sofa right now, is to be investigated and truthfully determined. It might be much easier to say that cases are cases and that facts are facts, whatever their epistemic status is, and then look into how that issue is handled rationally. What's more, contingent statements are relative to time, not only relative to space. Thus, if one could eliminate the predicaments associated with truth values and time related conditions, then one might contribute to justifying the Kantian notion of *synthetic a priori knowledge*. This was not the original aim of OccLog but it may underpin the idea. The objective of OccLog was to develop a descriptive apparatus that was able to propose formal descriptions of syntactic constructions in natural languages, and a rudimentary version of a combinatorial system for that purpose was presented in my Doctoral Thesis in 1994. In 2013, I published a book with Bloomsbury Academic [9] in which I offered an extended version of the system and an account of some basic notions in what is perceived as the logical basis, the formal language, of the system: *Occurrence Logic*.

The point of departure is the assumption—that the problematic situation that emerges because of the interrelationship between truth-functional (formal) logic and epistemology incorporated in the proposition 'knowledge is true justified belief'—could be overcome if one just abandoned the idea of truth. Notwithstanding the huge amount of work on the notion of 'time', including the development of so-called 'tense logic' by, e.g., Arthur N. Prior, see [10], I am inclined to accept Kant's claim that the notions of 'time' and 'space' are forms of *Anschauung*. The German word *Anschauung* is by [7] (p. 220) translated as 'intuition' (e.g., [7] (p. 196), footnote) but I would prefer the English word 'ASPECT' which I see as closer to the German meaning. Furthermore *Form der Anschauung* could then be 'aspectual mode'. It follows, then, that 'time' is something that is an effect of the way human cognition (*Erkenntnis*) works according to the principles of reason (*Vernunft*), and, accordingly, time is not something out there in the physical world. The same goes for 'space' in the ordinary sense of the word. In the mood of [11], one may favour the view that reality does not exist along with observing that the theoretical physicist labels one of the chapters in his book: 'Time Does Not Exist' [11] (p. 151). Of course, the good question is, then, what should we do with the world and the universe? It seems to be out there? The way I understand Kant he did not deny that there are things 'out there' but only that we will never be able to *know* their *essence* ('the thing in itself' *das Ding an sich*; see, for example [12], a question I shall not contemplate further. I will just suggest that we call the dynamic universe we live in, and which we are are today able to observe, 'the MATERIAL world', as opposed to what our brains are able to generate: 'the MENTAL world', and *both* are assumed to be PHYSICAL entities. Accordingly, if there is no time there is no need for truth. This undermines greater parts of classical philosophy, which (classical philosophy) hinges on logic and truth, but I see no alternative.

The idea of truth may be assumed to have emerged with language, which humans apparently have used for about 50,000 years. When you have language you are able to talk about things that are not part of your perceivable environment, for instance things far away, or what happened yesterday (one could say that time was invented by the emergence of language), a charactistic called *displacement* by linguists. With that came the opportunity to tell lies, and the idea of telling the truth may have had an essental influence on the birth and evolution of formal, and in the end modern symbolic, logic. The untold story is, then, that it is presumed that only humans can tell the truth—as opposed to lying—and therefore will master the art of logic, and, consequently, the art of knowledge and cognition. Animals do not have that specific ability of thinking logically and of knowing. What animals can do must, then, have another label and some people talk about animal intelligence.

If OccLog is accepted and we abandon truth (and time: *no Truth and no Time*, motto: no *T & T*) we have no need for such distinctions and we will be able to handle the states and events of the world, and our knowledge about them, a little easier. I shall therefore offer a short account of OccLog as an extract from [9] between »» and ««. Only minor details have been edited in order not to make the extract fit into the context of this paper It should be observed that in the following the OccLog is 'translated into' traditional symbolic logic in order to illustrate the parallel mechanisms in the two kinds of logic. In [9], the

OccLog and its application as a combinatorial system was developed as an independent system eliminating truth conditions from the specific formalisms that were intended for application in descriptions of occurrences of (in this case linguistic) entities.

3.1. »» Occurrence Logic: A Formal Language

(I shall openly acknowledge that a paper with the title 'The Logic of Occurrence' (1986; no information about its publication is offered) by Kenneth D. Forbus, Professor of Computer Science, is available at: www.qrg.northwestern.edu/papers/Files/loo(searchable).pdf. http://citeseer.ist.psu.edu/viewdoc/summary?doi=10.1.1.55.4080, accessed on 13 April 2022. It deals with: 'A general problem in qualitative physics is determining the consequences of assumptions about the behavior of a system.' I had no previous knowledge of this paper when I outlined my 'occurrence logic', and I have found no other suggestions about creating an 'occurrence logic' of the kind I propose in this context. The folllowing is a slightly modified citation from [9] (pp. 99–102)).

Not everyone is granted the liberty of proposing a new kind of logic, even though people in the business come up with new ideas all the time, and the number of contemporary logical systems is fairly high (cf., e.g., [13]. A fundamental question associated with that theme is, as is mentioned above, whether logical systems are entities that are independent of natural languages or whether they are entities that are extracted from, and designed on the basis of, natural languages. In accordance with my general approach to artificial languages, I am in favour of the last option. Thus, I consider my Occurrence Logic an artificial (formal) language, and I will make no further comments on this issue, but some comments on how this logical system has been designed seem to be appropriate.

In general, the vocabulary and the rules of OccLog seem to correspond to, and to be in accordance with, the truth-functional relations established in traditional symbolic logic. But this is not quite so and the line of reasoning advanced in the following will be illustrated by the problem connected with the term 'implication' used as the label of one of the operators.

In the tradition, one is allowed to infer the possible truth values of a proposition q from the actual truth-value of another proposition p, for instance: $p \rightarrow q$ 'if p is true, then q is true', i.e., the truth values of conditional compound statements depend on the pattern of truth values of their components (Material Implication). It means that only in case p is true and q is false the compound statement is false, and in all other cases with different patterns of truth values, the compound statement is true; which, of course, is the way Material Implication is defined. These truth functions are the reason why [14] in his textbook stresses the fact that: 'It should be noted that the material implication symbol is a truth-functional connective, just like the symbols for conjunction and disjunction.' And in the case mentioned where p and the compound statement are true, we are allowed to claim that q also is true by necessity (Modus Ponens: $p \rightarrow q$ 'if p is true, then q is true'). But, evidently, q may be true also when p is false, and therefore we cannot infer from the fact that q is true to the conclusion that p is true; only that if q is false, then p has to be false if the compound statement is true (Modus Tollens: $\neg p \rightarrow \neg q$ 'if p is false, then q is false'). But, evidently, as is the case with the other connectives (conjunction and disjunction), we cannot infer the pattern of truth-values of the components on the basis of the truth-value of the compound statement of an implication.

When dealing with occurrences of entities, one may say that it follows from the rule of the formula $z > y$ (y occurs if and only if z occurs) in the combinatorial system that one is allowed to infer from the occurrence of y to the occurrence of z. And this is in accordance with the conventions of the Occurrence Logic. Thus, the formula does not mean that z and y are logically equivalent (Material Equivalence), because z and y are not propositions but symbols (representing entities in the system for syntactic analysis implemented in Götzsche 2013 [9]) which either occur or are absent according to the rule combining them. The formula can be translated into propositions of Occurrence Logic and, thus, it 'means' the same thing as Material Implication ($\rightarrow$) in symbolic logic, but in a reversed notation: (The symbol '$^{\circ}$' attached to another symbol, e.g., in '$^{\circ}>$' or '$^{\circ}\rightarrow$' means that the symbol is an OccLog operator. If the OccLog operators/connectors appear without the '°' symbol then they are operators in the Formative Grammar combinatorial systems.)

combinatorial system rule:
z °> y, y occ iff z occ (i.e., y occurs if and only if z occurs)

occurrence logic propositions:
p: 'y occurs'
q: 'z occurs'

symbolic logic inference (Modus Ponens):
$p \to q$ 'if p then q'
p 'p is true'
... q 'therefore q is true'

occurrence logic inference:
p 'y occ' → q 'z occ'
'if (it is true that) p 'y occurs', then (it is true that) q 'z occurs''
p '(it is true that) p 'y occurs''
° ... q 'therefore (it is true that) q 'z occurs''

That the formulae z > y and $p \to q$ can, some way or other, be said to be reversed or inverted versions of each other should be evident when the symbolisms of symbolic logic and occurrence logic are compared by the following formulae (Material Equivalence: ≡):

p → q ≡ p 'y occ' °→ q 'z occ'
p 'y occ' °→ q 'z occ' ≡ z > y
p → q ≡ z > y

I call the occurrence rule mentioned (z > y) STRONG 'IMPLICATION'—I chose the expression *strong* for it not to be confused with *strict implication* as suggested by C. I. Lewis—because of the relationship with the logical truth function of Material Implication and because of the relationship of necessity between the occurrence of the components. The so-called WEAK 'IMPLICATION' is the more direct translation of the logical function into the occurrence logic and the combinatorial system, and therefore, p and q have to represent the opposite occurrence propositions as compared to strong implication:

combinatorial system rule:
z } y, if z occurs then y by necessity occurs

occurrence logic propositions:
p: 'z occurs'
q: 'y occurs'

symbolic logic inference (Modus Ponens):
$p \to q$ 'if p then q'
p 'p is true'
... q 'therefore q is true'

occurrence logic inference:
p 'z occ' °→ q 'y occ'
'if (it is true that) p 'z occurs' then (it is true that) q 'y occurs''
p '(it is true that) p 'z occurs''
° ... q 'therefore (it is true that) q 'y occurs''

And, again, the symbolisms of traditional logic and Occurrence Logic can be compared by the following formulae (Material Equivalence: ≡):

p → q ≡ p 'y occ' °→ q 'z occ'
p 'z occ' °→ q 'y occ' ≡ z } y
p → q ≡ z } y

Thus, it will always be true that if z occurs, then y will also occur, but y may occur for other reasons (caused or effected by other conditions), and accordingly p may be false while q is true, and this is the reason why I call it a weak 'implication'. ««

In a later version of the OccLog the 'strong implication' notation has been updated so that it reflects better the notion of 'case of occurrence' expressed in the phrase 'if and only if'—traditionally symbolised 'iff'—applied to OccLog:

z °> y, y occ **iff** z occ (i.e., y occurs if and only if z occurs)

is substituted by:

z °> y, y occ **icc** z occ (i.e., y occurs *in case and only in case* z occurs)

The end result of the development of OccLog is, firstly, that it solves the Kantian problem of 'a priori synthetic' propositions and knowledge. To decide what a triangle is, if you come across one, is just a matter of empirical evidence and rational reasoning in the end, if it has some pragmatic usefulness. Secondly, the symbolised language of OccLog and the symbolised language of the thereupon developed combinatorial system (EFACS, see below) may be appropriate as a high-level coding language for software. That is, although, not up to me to determine.

3.2. The Formative Grammar Approach

The formal system briefly accounted for above is part of an overall approach to theory and analysis in linguistics, including a solution to the problem of what semantics is and what semantic knowledge is. The label Formative Grammar refers to this alternative approach, and this label has been chosen because the concept 'formative' has two meanings:

- something that takes a profound part in the development of something specific, for instance a human being, or
- the smallest meaningful expressions of a language.

Noam Chomsky used the word *formative* in his book [15] in the second meaning. In Formative Grammar, a grammar is seen as a cognitive system taking care of the way linguistic expressions are handled when they are articulated. One can say that, when somebody says something, one always has to convince the listener to believe that the series of words are in accordance with the 'official grammar' of that language. If not, the listener may say that you are an immigrant, a child, or may express other unpleasant opinions. It follows that the grammar of a language is, in its usage, always utilising the pre-existing grammar by creating it over and over again. A grammar is not a stable system the way it is often accounted for in textbooks. Since this approach is directly relevant to, first, what formal languages are, including how, e.g., programming languages are developed; and, second, how the brain can be assumed to utilise a specific cognitive system to connect language and the real world out there, a semantics, I shall offer a few remarks on the benefits of the Formative Grammar (FoG) approach.

3.3. The Advantages of Formative Grammar in Natural Language Parsing

In Formative Grammar, the basic assumptions are that, as a language user,

- you don't pick up parts of words piece by piece which are then put together—they are stored as complete packages and only new words are 'made from the ground'— (It should be noticed that in the FoG theory there are not assumed to be 'words' in human speech, only in writing. As pointed to by [16] it is, in human articulation and speech sounds, not possible to identify words as segments. In FoG spoken minimal linguistic expressions are labelled MORPHEMES; when they are instantiated in a sentence (a syntagm) they are called FORMATIVES.);

- you don't relocate the words, for instance the way it is done in Chomskyan tree-diagrams, when they have been picked up—on the contrary, you pick up the words in the order they are to appear in the sentence;— and
- a sentence is a singular event; which is not a modification of other sentences, and never comes back when it has been uttered (unless you record it).

Accordingly, so-called passive sentences are not, in a Chomskyan way, seen as mutations of corresponding active sentences:

the man fed the dog <≈> the dog was fed by the man

They are just different sentences that, by accident, have similar meanings. When, for instance, traditional grammar says that in English the preterite of *spell* is *spell+ed* (because the ending is, evidently, *-ed* for the preterite and past participle) Formative Grammar will say that all the word forms

spell (the imperative)
(to) spell (the infinitive)
spells (the present, 3rd person)
spelled (the preterite)

are separate words with the same basic meaning but different supplementary meanings because of their morphological features; either sound features or spelling features. Therefore, they are stored in the cognitive systems as such and in such a way that they are easily accessible. This means that in Formative Grammar words can be handled by simple systems, provided the systems have very large capacities (as the capacities of our brains);furthermore, it means that the linear order in which the words are articulated can be handled by a simple system, albeit a very fine-tuned dynamic system. It should be observed that the formal systems of Formative Grammar

EFA(X): Epi-Formal Analysis in Syntax
EFASE: Epi-Formal Analysis in Semantics
EFACS (epi-formal combinatorial system)
Occurrence Logic

all live up to the criteria exemplified in Wang: 'Towards the abstract system theory of system science for cognitive and intelligent systems', in [17].

It should, furthermore, be observed that FoG also differs from so-called "dependency grammars", which (at least in the past) have been widely used in Natural Language Parsing. Dependency grammars take words as basic units in sentences and try to find their interdependencies. Yet, words are not such basic units in syntax. The basic units in syntax are CONSTITUENTS in SENTENCES (see [9]) expressed as either MORPHEMES (in western alphabetic script WORDS) or PHRASES.

The formal systems of Formative Grammar (FoG) have been developed in order to make descriptions of the assumed cognitive systems generated by the brain. It should be emphasized that *the approach does not entail a theoretical concept, or notion, of 'language' as such*. As opposed to, e.g., the Chomskyan theoretical framework in which there is supposed to be a kind of 'language organ', FoG says that the brain generates a number of cognitive and physiological systems, and subsystems, that are able to process the different parts of what we experience as 'language', i.e., the fact that oral (speech) sounds can refer to things in the world. The question about the existence of what we call *languages* (and *dialects*) is another one. One of the systems is the one taking care of what we call syntax, i.e., the linear and morphological features of linguistic expressions—as just mentioned—and a formula handling, for instance, the syntax of Danish (the language of which the system was developed) is represented by this calculus (see also Appendix A to this paper):

```
# Dan CST calculus [STC formation:  construction]
## parameters (>Ωz etc >:  strong subseql impl):
∑>Ω(c)πcΩs\{x}πs\{x}Ωvπv\◊aux◊Ω{s}π{s}/{o[m*]}Ω(a)πpa/qa/nz
Ω(v)πv/◊{aux}/vrb/vva◊/{ra}Ω(o/p)π{p}/o/{vva}>{o}/p/{s}/kc^kp
Ω(a)πra/pa>∑
special morphemic conditions:  [*mig, dig, sig, ham, hende, den,
det, os, jer, dem]
```

The calculus is able to yield structural and formal descriptions of natural language sentences, and it has been developed by utilizing the characters found on most western keyboards so that no unconventional glyphs are needed.

The interaction between the linguistically relevant cognitive systems is assumed to be able to generate what we call knowledge, as is characterised above, and knowledge is often associated with how we understand, or more specifically 'grasp', the things in the world and how they work. This 'grasping' mechanism is often associated with an idea of 'concepts' in the minds of humans. I shall, therefore, bring into focus the issues of what concepts are and how they work, thereby implicitly asking the question: can machines have concepts?

4. On Conceptualisation and Semantics

The peculiar thing is that the word *concept* may be, at least moderately, frequent in English but at the same time its meaning is fairly opaque, it is either polysemantic, or vague or in the form of homonymous lexemes. To illustrate the issue, one may check dictionaries and encyclopaedias; the content of which I do not intend to present as direct scientific evidence, only to demonstrate some general meanings and how meanings are filtered by professionals. The built-in dictionary on my Mac defines *concept* as:

an abstract idea: *structuralism is a difficult concept | the concept of justice*;

- a plan or intention: *the centre has kept firmly to its original concept;*
- an idea or invention to help sell or publicize a commodity: *a new concept in corporate hospitality*.

Of these suggestions the basic synonym is the word *idea*, i.e., the—so to speak—'idea' we find with the British Empiricists. If we try Encyclopedia Britannica online, we find that:

> ... **concept**, in the Analytic school of philosophy, ... Concepts are thus logical, not mental, entities.

This brings us to the intricate question, what is a logical entity? We need not go into that, only accept that we are back at the traditional, or classical, philosophical fusion of formal logic, epistemology, and the ontology of mind. Yet, also observe that, at least to my knowledge, any formal semantics analysis has this as an implicit assumption unless logical concepts are explicitly embedded in a theory of cognitive functions.

In addition, just a few words about this. I will not go into the topic of Philosophy of Mathematics, only illustrate the question of a priori synthetic knowledge by taking up the question of whether mathematical objects exist, as formulated by [18]:

> The old topic is the ontological status of mathematical objects: do numbers, sets, and so on, exist? The relatively new topic is the semantical status of mathematical statements: what do mathematical statements mean?

If this is abbreviated as: does a triangle exist (beyond graphic and other instances), and what does the statement 'a triangle is a flat shape that has three straight sides and three angles' mean, then there are a minor number of answers. The answer put forward by [18] is that in a 'model-theoretic scheme':

> We now approach Benacerraf's dilemma. From the realism in ontology, we have the existence of mathematical objects. It would appear that these objects are abstract, in the sense that they are causally inert, not located in space and time, . . . Ref. [18] (p. 3)

> . . . this requires epistemic access to an acausal, eternal, and detached mathematical realm. This is the most serious problem for realism. Ref. [18] (p. 4)

And [18] maintains that:

> In line with Benacerraf's desideratum, I propose that model-theoretic semantics is the central frame of philosophical realism.

As can be seen from this, [18] is in favour of 'realism' in a 'model-theoretic understanding', which implies that we have the problem of how we know, by means of true statements, that mathematical objects exist. Shapiro's answer to this is that:

> The philosophy of mathematics to be articulated in this book goes by the name "structuralism," and its slogan is "mathematics is the science of structure." Ref. [18] (p. 5)

> . . . the structuralist holds that the subject matter of, say, arithmetic, is a single abstract structure, the natural-number structure. Ref. [18] (p. 9)

and

> . . . structuralism is a variety of realism. A natural number, then, is a place in the natural-number structure. Ref. [18] (p. 6)

This is not easy. On p. 12 the word *structure* is found 16 times, but Shapiro has no suggestion about what a 'structure' is. In Philosophy of Science we often learn that the notion of 'structure' means a number of different things depending on the context—even though the Stanford Encyclopedia of Philosophy has no single entry on the word—but Shapiro has the concept of 'structure' as an explanatory predicate; quite many things are 'structures', while we in the end do not know what a structure is, not even as a metaphysical notion. And then, what to do with the notion of 'abstract structure'? The word *abstract* is an often used word but seldom explained. Of course, if we accept this approach then a triangle is 'a geometric structure', and as such it does exist and we therefore have knowledge about triangles. The question, if this knowledge is a priori, is—the way I read Shapiro—put aside on p. 111, and the question, if a statement about triangles has a reference to such a triangle, is reduced—to the extent that I understand Shapiro—to 'abstraction or pattern recognintion' [18] (p. 112).

To be fair, [18] has some remarks on non-realism in the form of so-called *anti-realism*, for instance on p. 15 referring to, among others, Michael Dummett's so-called 'intuitionistics logic' and what Shapiro calls Dummett's 'assertabilist semantics' (p. 15). Personally, I am much in favour of Dummett's approach, apart from the idea of intuition (see also [19] but Shapiro does not furnish us with a clarification of what the *concept* of a natural number is in the citation above: 'A natural number, then, is a place in the natural-number structure.', for instance the number five (5). Neither can we deduce from realism what a concept of a triangle is. Maybe it would have been easier if the question had been asked in German, in which language there are different words for 'different kinds of numbers':

> **Zahlen** sind abstrakte mathematische Objekte beziehungsweise Objekte des Denkens, die sich historisch aus Vorstellungen von Größe und Anzahl entwickelten.

> Die **Anzahl** ist eine physikalische Größe oder ein Rechenwert, als Maß dafür, aus wie vielen Objekten eine Menge besteht. Sie wird durch Zählen bestimmt. Sie ist eine Angabe der Quantität.

> Das **Zahlwort** oder *Numerale* (Plural Numeralia, Numeralien oder seltener Numerale; (1) von lateinisch [nomen] numerale), seltener Numeral (2) wird in der

> Sprachwissenschaft manchmal als eigene Wortart angesetzt (die Dudengrammatik zählt allerdings sogar auch die Kardinalzahlen zu den Adjektiven (3)).

These are the definitions (slightly edited by the author of this paper) found on Wikipedia, which is linked to by [20] which is the website of the *Wortschatz Leipzig* dictionary concerning word definitions. It appears that there are three 'kinds of numbers': abstract mathematical objects (in the mind), physical numbers (amounts out there), and words for numbers (linguistic expressions). As well, there is the word *Ziffer*, which means 'number figure, integer', what I would call 'a symbolic number figure'. Compared to that, English has a more blurred vocabulary because the word *number* may refer to quite many things, and a *numeral* in English may also be a 'number, integer, figure, digit'. The 'three-layered' German terminology—which is also found in the Scandinavian languages—seems to reflect most adequately the ontological 'real world' in that one cannot deny that we have words for numbers (*Zahlwort*), we have symbols (such as 5) for numbers (*Ziffer*), and we have numbers (amounts) of things out there (*Anzahl*). It might also be unwarranted to say that we have no representations of numbers in the mind (*Zahl*). If not, quite many things would be impossible to do.,We are, nonetheless, now back again to the question about the nature of such representations. Personally, I find it particularly hard to accept the idea that we have in our minds 'abstract objects', even though a high number of philosophers have written a fair amount of pages about them.

The adjective *abstract* is especially ardous to handle because its meaning is context-dependent (polysemous) and its use is almost ubiquitous. The closest one comes to a clear-cut definition is in the Encyclopaedia Britannica (online):

> **abstraction**, the cognitive process of isolating, or "abstracting," a common feature or relationship observed in a number of things, or the product of such a process.
>
> ...
>
> What is abstracted—i.e., the abstraction or abstractum—is sometimes taken to be a concept (or "abstract idea") rather than a property or relation.

Taking the phrase *abstract idea* at face value it could be a mental image of something in the outer world, but that does not quite fit the idea of 'abstract mathematical objects' as postulated by Shapiro above, because there are no 'some numbers five (5) in the outer world', only *Anzahlen*, for instance an amount of five (5) dogs, which is not by itself an image of the number five 5, only an amount which must be counted in order to realise that it has five members. Unless one is able to perform so-called 'subitizing', which is a spontaneous correct assesment of a small number of items; with larger numbers this would not suffice. Subitizing can only be performed with minor numbers—it will be more difficult with, e.g., 25 or 250 items. The same happens with a triangle. If you need a triangle in order to fix a piece of furniture, then the question of whether your triangle is perfect is not relevant, only if it is applicable is relevant, i.e., functionally useful. It all depends on what demands of accuracy and precision are needed in the context. The edges in wood may not be totally 'straight lines' and one or more angles may be 'open' and not closed, in which case the figure is not a triangle but another kind of polygon. Which leads to the conclusion that the 'triangle' in your mind is not the mental image of the piece of wood, but 'an abstract concept' about which people may debate its existence. Because, is the 'abstract concept' of a triangle in your mind really a perfect triangle, or is it just a definition? And, furthermore, we still do not know what a 'concept' *is*? In linguistics it is often confused with what may be called a mental image (something like Kant's *Vorstellung*). It seems, for instance, to be the way it is used by the linguist Ray Jackendoff (see [21] (p. 6), but that is not uncontroversial considering the English Language Empiricists (see above), and it cannot be an answer to the question what a 'logical entity' is (see above).

In [9] the word *concept* is used 91 times, and I shall propose the following definition:

> **Concept (cpt)** a mental connection between one specific linguistic expression and the [mental] configuration(s) of one or more (kinds of) objects, states, or events, etc. which are observable, assumed, or fictive; or a connection between two or

> more linguistic expressions and the [mental] configuration of one (kind of) object, state, or event, etc.

This definition acknowledges that apart from words (linguistic expressions in a broad sense) and mental representations in the form of images (including all recordings of perceptual input, such as, for example, auditive perception) it is fairly hard to find something, an entity, in the human mind that conforms to our idea of a 'concept'. I shall therefore suggest that there can be said to exist CONCEPTS, but that they are RELATIONS as defined above. If this is not accepted, then either you have to see mental images as concepts, or there is no way out of the predicament. How Kant sees it is, to me, not quite transparent—[7] deals with it on pp. 45–54—but I may, with all due respect, say that he might not have objected to my idea. In the interpretation by [7], Kant connects concepts and 'understanding'—for example on the pages just mentioned—but I do not intend to take up this perspective. In my view understanding is a notion that is part of what [22] (p. 16) call 'folk-psychology', a terminology that is part of human daily life and intersects with psychological science and therapy. It can, however, hardly bear on details concerning cognition and to what extent machines can emulate human intelligence.

This specific issue is a matter of how the mind—also assuming my proposals above on cognitive mechanisms and what concepts are—is generated by the brain. It will therefore be appropriate to see if my suggestions can fit into this field of research.

5. The Brain: A Short Story

It has, for some time, been a common practice to approach the issue just mentioned by reducing the frame of understanding to neurons and neural networks. The idea has been that if we could only get the total picture of the workings of these mechanisms then we could imitate this mechanism in software, and the problem would be solved. As pointed to by [3], this seems to have led to quite many dead ends and to the insight that things are not that simple. First:

> We do not understand the detail of how the brain is put together, except in the simplest of organisms such as C. elegans. Ref. [3] (p. 244)
>
> Further:
>
> . . . the widely held assumption—or dogma or simply hope—that underpins work om connectomes is that describing the wiring diagram of a particular organism or of one part of its brain will enable new insights into how behaviour and sensation emerge from the activity of neural circuitry. Ref. [3] (p. 247)
>
> However:
>
> . . . work by researchers on simple nervous systems suggest that connectomics . . . will fail to explain what is going on unless accompanied by both experimental and modelling approaches. Ref. [3] (p. 247)

My own FoG approach mentioned above can be integrated into such a model. Concluding from [3] Cobb (2022), we do not know how the brain generates the mind (Cobb: 'behaviour and sensation'), whereas my model in combination with my experimental work on dyslexia may cast, at least some, light over how the brains' emergent model of the world (or, what I would call the MENTAL UNIVERSE) works. Is there, then, a way forward for software systems undertaking the task of mimicking detailed brain functions for a computer to 'behave' as a human being? Not at face value:

> . . . just because a program generates something that is similar to a brain-produced behaviour, that does not mean that the two systems share either structure or function. Ref. [3] (p. 274)

In 1957 Von Neumann had already pointed to the fact that there are 'differences . . . between the computer and the brain' ([23] (p. 3) in that (citation from Von Neumann 1957)):

> The natural componentry favors automata with more, but slower, organs, while the artificial ones favors the reverse arrangement of fewer, but faster organs.
>
> . . . the logical approach and structure in natural automata may be expected to differ widely from those in artificial automata. Also, the memory requirements of the latter will be more severe than those of the former. Ref. [23] (p. 4)

On that background it may be a little surprising that the 'neural network' analogy is still the research scheme in, for instance, Natural Language Processing (NLP) the way it is, e.g., depicted in [24]. But, of course, there may be alternative approaches.

In parallel with the fact that there are lacunae in our understanding of the brain and its model of the world, we can consider some of the basic functions of *what* the brain is *doing* when generating 'its model of the world' (or MENTAL UNIVERSE (MU)). In a recent approach to this issue there is a theory saying that:

> Brains, it has recently been argued, are essentially prediction machines. . . .
>
> . . . it offers the best clue yet to the shape of a unified science of mind and action. Ref. [25] (p. 1)

Clark's [25] paper is a so-called meta-analysis incorporating responses from authors and rejoinders by Clark himself, so it can be perceived as an authorative presentation of the theoretical framwork. The presentation starts with a citation:

> "The whole function of the brain is summed up in: error correction." So wrote W. Ross Ashby, the British psychiatrist and cyberneticist, some half a century ago. Ref. [25] (p. 1)
>
> Thus:
>
> In particular, one of the brain's key tricks, it now seems, is to implement dumb processes that correct a certain kind of error: error in the multi-layered prediction of input. In mammalian brains, such errors look to be corrected within a cascade of cortical processing events in which higher-level systems attempt to predict the inputs to lower-level ones on the basis of their own emerging models of the causal structure of the world (i.e., the signal source). Ref. [25] (p. 1)

This means that the traditional idea that the input from, for example, visual perception is continuously uploaded to the visual cortex in order to keep the brain's world model updated—which must be said to be crucial to an organism's survival—is not justified. Instead one can say that the continuous stream is from the brain's world model to the perceptual apparatus for it to check that no errors in the brain's prediction tasks are made. It follows that the 'predictive brain' will, so to speak, only 'notice' if something differs from its predictions, and this is, of course, much more favourable to the organism's energy balance. In every day language, one could say that a continuous bombardment with perceptual input might quickly make the brain burn out. Therefore:

> Notice how different this conception is to ones in which the problem is posed as one of establishing a mapping relation between environmental and inner states.
>
> One key task performed by the brain, according to these models, is that of guessing the next states of its own neural economy. Ref. [25] (p. 3)

The guessing is based on probability that is based on statistics, the so-called Bayesian approach, and the brain is, then, both predictive and 'computational' (the term found on 40 pages of Clarks paper including comments), but I might prefer to talk about 'calculation' instead of 'computation'. Nevertheless, the theory presumes a high number of details to be scrutinised before it becomes full-fledged, and I shall only take up a few of the open ends mentioned by Clark whose paper I shall highly recommend.

The first question to be asked is: what is a predictive error? It can be illustrated by the scenario in which I drive along a highway near my Italian hometown, and I drive routinely because 'nothing special happens'. Most of my visual sight is beyond focus. It is blurred, which I actually also let my focus become, justified by the fact that there are no surprises, 'the car almost drives by itself'. There is then an American looking truck approaching, next a military vehicle, and in the end a Russian tank of unknown origin. This is the question of *relevance* in that the American truck is a matter of my personal interests, the military truck may have to do with international politics (allocating troops), and the tank may be a matter of unpleasant things approaching. This vastly primitive scenario may exemplify the huge amount of theoretical issues associated with the idea of the predictive brain, but it also demonstrates the complicated tasks the brain is given to make the organism survive in a sometimes thorny environment. One of the unpleasant features of the outer world is that one may be presented with facts that do not quite fit in with one's inner world, or at least some of one's basic attiudes. How the brain handles such quandaries is taken up in the paper [22] on 'Self-deception in the predictive mind: . . . '. It is a popular saying that one should not challenge people's illusions (in severe cases, their delusions) because it can make people (sometimes very) angry. Well, the brain is also prepared for that, and the solution is the mechanism of '*main forms of self-deception*' [22] (p. 2) built into the 'predictive processing' (ibid.) brain, or PPB, which I would prefer to call it. They propose that:

> The fundamental tools of predictive processing are: perceptual inference, active inference and precision expectations. [22] (p. 3)

All of them work by, sort of, explaining away facts that are not acceptable to the individual brain's belief system, a kind of psychological device presumably often experienced as a feature of other people by people with a common sense attitude to life. Therefore, on the one hand, the theory about the 'predictive processing brain' (PPB) confirms every-day wisdom whereas, on the other hand, it has a number of open questions for new research that may lead to evidence with good explanatory potentials.

If the FoG approach (see above) is accepted as a part of the description of the cognitive systems generating what the PPB approach calls a 'model of the world'—and I call a MENTAL UNIVERSE—then its subsystems can function as parts of the predictive mechanism navigating the organism in the outer world, including the also linguistic behaviour of other people. Therefore it would also be able to offer a hypothetical but consistent description of how linguistic meaning, and thereby semantic knowledge, works. A description that can be experimentally tested.

A part of the theoretical framework incorporating semantic knowledge is the notion of 'concept', as defined above. It should be emphasized that *semantic knowledge works as the cognitive processes generated by the brain in that there is a relation between meaning in the form of mental images and linguistic expressions. It implies that* ***concepts*** *are (only)* ***relations*** *and as such defined accordingly*. Furthermore, 'concepts' have no existence beyond that, and linguistic semantics can only be satisfactorily accounted for by a theory that incorporates how the outer world is handled cognitively, presumably in the form of mental images.

Concepts can be represented by symbols, as in symbolic logic and mathematics; still, as just mentioned, they do not exist independently of linguistic expressions and mental images. They may be ABSTRACT, defined as: an abstract concept is a concept that has been 'deprived of' one or more of its specifications/features. Technically only concepts can be abstract, meaning that either their mental image(s) and/or linguistic expression(s) undergo an abstraction process. In language usage the word *abstract* is, of course, found in other contexts, either as an adjective or as a noun, but then it may be debated whether it is one polysemous lexeme or if we are dealing with different words.

The above proposed fragments of a model represent, some way or other, some of the mental, cognitive functions that the brain must be assumed to generate. The question is, then, can this be emulated by software systems?

6. How Artificial Is Intelligence?

There is no doubt that, at the outset, so-called Artificial Intelligence was a label in which this compound word worked as a linguistic trope. As mentioned above, 'intelligence' is not a clear-cut technical term, and considering the individual implications of intelligence tests as a measure of brain capacities and abilities, such tests may not be the most suitable identifiers of bright minds. After having spent about 50 years teaching in some kind of education system, I may be inclined to say that the only thing that a specific outcome (for instance numeric in the form of a score) of an IQ test proves, is that it has this specific outcome (for instance numeric in the form of a score). What implications an IQ test will have beyond that is unclear. But, by all means, in that sense IQ tests are truly artificial. Another question is, as mentioned above, whether the basic brain function of generating semantic knowledge can be imitated in software? The answer is that one option may be to implement the mechanisms described by the FoG approach extended to a theoretically consistent cognitive model in a way that resembles what humans do. It means that its subsystems should, in principle, be doing the same jobs as are assumed as functions in humans, regardless of how things are coded in the software and regardless of how it may look on a screen. Taking visual perception as an example, one could imagine a system that made computer vision (see [26] (pp. 875–939) 'project' input and store it over time, thereby building up something resembling human accumulated experience. If the other subsystems were emulated, we would have the first fragile fragment scaffold of a 'golem', though it undoubtedly would take some time to accumulate the experience of just a small human child. The difference between my system and 'robot-like' electronics would be that it would not be the ubiquitous impersonating systems of today; systems that just manipulate linguistic-like and other expressions, or translate between modes.

One of the things that I find tricky with systems using, for instance, Natural Language Processing (NLP) is the frame of reference when dealing with particular issues:

> Grammar . . . is the set of rules that define the syntactic structure and pattern of words in a sentence. Because these rules are generally fixed and absolute, a context-free grammar (CFG) can be used to represent the grammatical rules of a language . . . Ref. [24] (p. 100)

I am not sure that all—or many, for that matter—linguists will countersign that statement. The claim does not take into account that languages are *not* 'fixed and absolute' but are, in language use, recreated and changed all the time. This is why my FoG approach (see above) perceives a language as a dynamic system that, on the one hand, is describable by a formal system, but, on the other hand, must be open to undergoing adjustments all the time. Only in a grammar textbook is a language 'fixed and absolute', and its rules are not the mental 'fluctuating imprints' of language usage that babies learn, under normal circumstances. This may be the reason why the approach in [24] has invoked 'probabilistic context-free grammars' (PCFG) (ibid.), because, as mentioned above on 'the predictive brain', probability is essential in language learning and language use. Semantics is also a problem for Kamath et al.:

> . . . labelling "dog" as a noun gives us no clue what a "dog" is. Semantic representations give a sense of meaning to words and phrases. They attach roles to word chunks such as person, place, or amount. Semantic analysis is interested in understanding meaning primarily in terms of word and sentence relationships. Ref. [24] (p. 101)

This appears to be the well-known 'thematic role semantics' that says that the meaning of a word can be accounted for by substituting the word with a number of other words, in this case labels called 'roles', which you in due course are supposed to know the meanings of.

There seems to be no doubt that systems that are being developed on this background are immensely useful, and it may be seen as harmless that users talk about their car or virtual assistant as capable of "understanding" what they say. However, in my view, the degree to which electronic devices make errors cannot be compared to the degree that humans make errors when talking with each other. This is because, as pointed to above, the human cognitive systems do not work the way electronic systems work. In discourse, human brains produce continuous feedback for clarification and elimination of errors. With a virtual assistant, errors are due to their non-optimal technical design.

7. Conclusions

The paper above holds that it is not possible to directly transfer the notion of 'semantic knowledge'—as a human process of making language generate and confer meanings—to machines and software. Machines are, evidently, able to handle large amounts of information by processing low voltage current, but that does not mean that the two kinds of system do the same things in the same ways. It would be a hyperbole on the part of machines and software to say that the brain is a computer. As mentioned, we do not know much about how the brain works when generating cognition; therefore, the author proposes that a model of cognitive functions may be emulated by software, at least as a point of departure. The author is working on such a model incorporating the essential functions of language.

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Appendix A

This is an example of the symbolisms in an updated version of 'Appendix B The EFA(X)3 (EFA(X)3.1) Formal System' pp. 185–199 in [9]:

```
EFAX3.0 & 3.3
 (03) occurrence logic (occ log)

 #variables and rules for occurrence of items

 ## occurrence strings & lists
 occurrence symbol strings & lists (non/occurrence relations):
 (° any operator, cf below)
 z°y°ä       string
     (string, def:  any combinatorial set of occ related symbols)
 z,y,ä etc     list
     (list, def:  any set of occ unrelated symbols)

 ## occurrence markers
 occurrence symbol markers (of absolute occurrence values):
 z        obligatory (OBL)
 (z)      facultative (FAC)
{z}       labile (LAB)
(lability, def:  occurrence value may be undefinable)

## occurrence operators
occurrence symbol operators (relative occurrence values (indicates
symbol co-occurrence (condition) relations)):

°       any operator
~       negation

connectives (binary operators):
```

```
°^      conjunction
°\      exclusive disjunction
°/      inclusive disjunction
°>      strong implication; def:  z °> y, y occ icc z occ
°}      weak implication; def:  z °} y, if z occ then y occ

consequential (relation of necessary co-occurrence in) strings:
°>z°y°zy°>        strong consequential implication
°}z°y°zy°}        weak consequential implication
```

For further information see [9].

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