Meaning as Differentiated-Cognition

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Abstract: The paper aims for a computational model in the theory of meaning. Meaning is conceived as cognition states that can be described in a compressed manner using the differentiated-cognition model. The structured content of that cognition or knowledge is a result of a computational process of extracting information from linguistic constructs by an ideal recipient. This structured content gives the semantic interpretation of sentences.

Keywords: language performance, language constraints, semantics, theory of meaning, language understanding, cognitive modeling

1 Introduction

A crucial issue in cognitive science and semantics is to understand and model how language is produced by the speaker and understood by the hearer. This is called a model of language performance. Even if some tangible progress can be acknowledged in the field of language competence, the identified constraints that language obeys seem of little relevance for language understanding modeling. The rules of a generative grammar, for instance, run backwardly do not yield to a working model of language understanding. A sentence does not need to be grammatical to be understood by a person. Grammar helps in sentence understanding but is not essential. Ultimately, the rules responsible for producing sentence structures may be completely unknown to the hearer and unimportant for deriving the meaning carried by that sentence.

Several approaches have been proposed for a theory of meaning [1] [2]. One theory is called the referential theory of meaning. Words are seen as mere symbols which trigger a process of reference to a thought object. So, words mean the object they make one to think of, and therefore the meaning of a word is the connection with that object of perceptive of thought reality. However, this theory has a drawback. For some words such as verbs, prepositions, connectives (e.g., nevertheless, since, however), etc. we cannot find appropriate referents. Also, some constructions may have the same referent without having the same meaning,

while other propositions are meaningful, true or false, but without definite reference.

Another approach is to associate meaning with truth [3]. Logic is viewed as the basis of understanding truth and meaning, and if reference fails to provide the link with objects, events, and states of affairs in the world, there is still truth that might do it. Meaning is explained in terms of truth rather than reference, based on verifiability as the criterion of empirical meaning. This idea led to several versions of truth (aletheic) theories of meaning. According to the verificationist theory of meaning, an expression is meaningful if there are some conditions of experience that could show that the expression is true. The truth theory might solve the drawbacks of the referential theory but encounters another. When trying to use a semantical predicate such as "…is true" we need to employ a higher order language (metalanguage), otherwise paradoxical constructions can result, as is for instance "This sentence is false." Therefore, the theory has to be restricted to clearly formalized, artificial languages, and the criterion of truth satisfaction applied to individual words. Thus, the meaning of a predicate, such as ". . . is sweet," is determined and known in terms of the set of objects of which it is true. But even in these conditions, the truth theory fails when facing classes of words of moral or aesthetic judgment (e.g., beautiful, good), connectives, pronouns, adverbs, etc., where the meaning cannot be decided in terms of truth. Besides evoking the truth, words are used in other dimensions as well, such as orders, promises (feasibility), advices and laws (moral value), regulations and prescriptions (utility), prayers and proposals, etc.

In order to avoid the above mentioned difficulties, that not all words refer to something and not all constructions are true or false, another more pragmatic approach tries to explain meaning in terms of how the speaker uses language to express intentions [4]. There are several versions of use theory, all derived from Wittgenstein's original approach. In his view, conversation is similar with playing a game where words are used like pieces in chess game. In this language game there is no truth. The meaning of a word is given by its contribution to the nature of the speech acts that can be performed by using that word. Thus, usage is the actual meanings that individual speakers have, i.e., the things that an individual speaker in a particular context wants to refer to. However, some critiques have been raised against use theories. One is formulated by the advocates of the *language of thought* hypothesis [5]. Thus, the use theories of Wittgensteinian kind seem to be committed to the notion that language is a public phenomenon, ignoring the existence of such thing as a *private language*. According to this view, the language of thought is an ontological necessity and requires the existence of a private language. Another difficulty encountered by the use theory arises from the unlimited possibilities of employing a given word in every conceivable context and circumstance.

Another major direction towards a theory of meaning tries to go beyond the language formalism in order to identify the thought structure of the speaker

(transmitter). Our approach goes in that direction and assumes that the speaker's purpose is to convey a thought structure, and therefore uses language to encode that structure, hoping that this code will be understood by the hearer. Understanding is equivalent with the formation of a similar thought in the hearer. Thus, meaning appears to be inseparably tied to such concepts as belief, judgment, desire, intention, knowledge, and understanding. This approach is rooted in the traditional conception that speech and thought are intimately related, and therefore language is an expression of thought. Therefore, meaning understanding presupposes the capacity of the receiver to extract and retrieve the thought structure of the transmitter from particular utterances. However, there is a difficulty here related with the fact that the same thought can be expressed by the transmitter in different languages and within a language in different paraphrases. On one hand, the thought states of both the transmitter and the receiver are subjective mental states, and on the other hand an objective procedure is required that can provide a 'representation' of those cognition states. If such a representation could be found then its structured content would be the so-called semantic interpretation of an utterance or sentence heard by a generic ideal recipient.

In order to solve this problem, we need another premise necessary to account the connection between language and reality [6] [7]. This pertains to the existence of relationships among concepts and objects that we perceive in the physical and mental universe. We use words to set up a language structure that describes or model these relationships or features out to each other. Thus, language appears to be dependent on an objective and external concept of reality or "truth" rather than worked out of a formalizable logical system. According to such a viewpoint we introduced in [8] the concept of differentiated cognition in order to describe cognition states, and explain by their structured content the meaning of sentences. The differentiated cognition model can be seen as a computational information extraction process. The purpose of this paper is to extend this approach and established the frame in which such a process may work.

2 Differentiated Cognition Model

The main premise in our approach is that cognition, in order to be specified and hence describable in an object language, has to account for a state of awareness where a distinction appears between a differenced word and a differencer (a word that particularizes or defines another word). Something is cognized as something else. For instance, a sweet apple is a state of awareness where a distinction and a relation are both cognized. The apple is the differenced word and the sweetness is the differencer. The differencer is inherent in the differenced word. If we conceive as a second premise that the relation between the differenced and differencer is

relative then we can account for different types of states of cognition. For instance, another type of cognition is that the sweet taste is in the apple. The sweetness becomes the differenced object and the belonging to the apple (or simply, the apple), the differencer. It may also be possible to have no differencer at all. In this case, the cognition reduces to the simple state of awareness or perception of the differenced. The differenced is not cognized as being something else.

It is interesting to note that such states of cognition are completely subjective, since only the subject knows the content of the cognition, and has the liberty of selecting the type of differenced-differencer relationship. The subject can then communicate her cognition state specifying precisely which word is the differenced and which is the differencer. The privacy property of cognition can be derived because of this relativity in choosing the differenced-differencer relationship. A situation may be described and cognized internally in many different ways, eluding thus any attempt for formal verifiability. In the same time, the speaker can communicate her intentions and utter constructions that may be cognized by the recipient in a specific differenced-differencer relationship. Also, besides differenced-differencer relativity, both the differenced and the differencer may be subject to multilayered specifications. Thus, cognition becomes a series of descriptions of one object in terms of others.

The central idea in the differentiated cognition approach is that an object-language cannot be structurally described by the same language, and therefore we need to employ a metalinguistic concept. According to this concept, we may know an object by its capacity to be known. If a certain object x is cognized as another object y, then we write $C(x, y)$. For instance, the meaning of the sentence "*The book is red*" can be cognized in the following terms: 'book' is cognized as being 'red', $C(b, r)$. The same meaning may be derived also from the simpler form: "*the red book*." Even if this construction might not be a definite grammatical sentence (because it doesn't contain a finite verb), it has meaning, and the differentiated-cognition approach proves suitable to describe the meaning content even in this case. Accordingly, we define a sentence as being any cluster of words that satisfies the differenced-differencer relationship and thus conveys meaning. In the above example, the cognition of the book being red is equivalent to the particular case of knowing the object (book) by its property. This should not be misunderstood that language, in this approach, is structured only in classes of objects and other distinct classes of properties pertaining to those objects, as is, for instance, the distinction between the subject and the predicate in classical logic and grammar. In the following sentence "*The knight rides a white horse*" the differenced is the knight and the differencer is the white horse the knight rides. Both the differenced and the differencer are particulars, and the relation between them is also particular. In a classical approach, riding a white horse can be interpreted as a universal predicate true of many particulars. Thus, the predicate as differencer must always be universal. In differentiated cognition approach the

distinction between the differenced and the differencer is relative, and the differencer may be either particular or universal. So, the same meaning of the above sentence can be cognized also from the construction "*The redness is present in the book*." Here, the object that is to be known is the *red*-ness which is cognized as being present in the book, i.e., the property of redness is to be present in objects like books.

Formally, the differentiated cognition description can be generalized and applied to more complex constructions. Let's firstly consider the sentence "*The horse has a white tail*." The meaning can be described in the following terms of cognized objects and their properties or qualifiers: a horse-object which is cognized as (having) a tail which is cognized as having white colour. The horse-object is called the head-cognized object (differenced). It is the object of cognition in respect to others and never a property or differencer. The tail is both object and property, and *white*(ness) is only a property. Thus, knowing the meaning is described as a series of descriptions of one object in terms of others. If we use the notation C(*x*, *y*) as it was introduced above, the structural cognitive description of the meaning content is obtained as:

C(*h*, C(*t*, *w*)), (1)

where *h* stands for *horse*, *t* for *tail*, and *w* for *white* respectively.

In this description, both the differenced and differencer are particulars. But the cognition can be further deepened if we consider that any word, differenced or differencer, which bears meaning can be known by its inherent capacity or quality to have that meaning. Any individual object is cognized as having a universal quality or property of object-ness. This is a self-referential process, and is the result of the metalinguistic description of meaning by differentiated-cognition. So, in our example, the object *horse* is cognized as its universal or generic property *horse*-ness, and also as the object *tail* which is cognized as its generic property *tail*-ness, and as the object *white* which is cognized as its universal property *white*-ness. It's interesting to note that some words are known as objects (differenced words) at one level of cognition and properties (differencers) at a lower level. Applying this generalized metalinguistic principle of describing meaning, the meaning structure of (1) obtained after successive substitutions is:

C(C(*h*, *h'*), C(C(*t*, *t'*), C(*w*, *w'*))), (2)

where *h*, *h'* stand for *horse* and *horse*-ness, *t*, *t'* for *tail* and *tail*-ness, and *w*, *w'* for *white* and *white*-ness respectively. This cognition description is about knowing a *horse* which is cognized as *horse*-ness and as a *tail* which is cognized as *tail*-ness and also as being *white* which in turn is cognized as *white*-ness.

Because of similar semantic structure, the differentiated cognition model can describe the meaning content of all declarative sentences. In order to put in evidence the differentiated cognition universal pattern, it is convenient to represent the meaning content description in the formalism of differentiated-

cognition-phrase (DCP), as in Figure 1. The occupant of the head position in DCP (in our case, the differenced word *horse*) is the central qualified object that is known by its properties denoted by the objects on the right side of the tree.

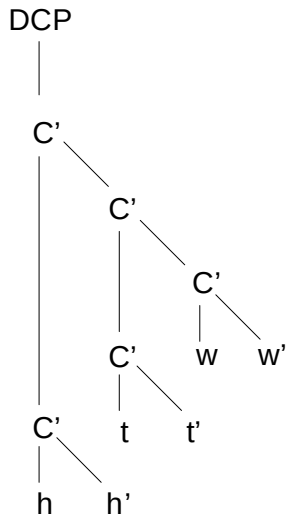

Figure 1
Differentiated-cognition-phrase representation of sentence "*The horse has a white tail*."

The above example has an usual semantic structure. The differenced word is an "object" and the differencer is one of its properties. The verbal element is irrelevant since its meaning is pointing to a possession or property. The second example we present is more relevant in using the DCP schema. The problem is how we select the word occupying the head position. This can be of verbal or non-verbal category since both types apply suitably well to the differentiated-cognition model.

Considering again the sentence "*The knight rides a white horse*" the nominal inflection element the *knight* can be the central cognized object qualified by the rest of the words. So, the *knight* is qualified by being the 'agent' or the 'doer' of the act of *riding* which is qualified by the object *horse*, which in turn is qualified by the colour *white*. The DCP tree will look like as shown in Figure 2.

If we choose the verb to *ride* as the central cognized object, then the meaning of the same sentence can be described as follows: the operation generating the act of *riding* which has a *horse* as object, having a *tail* qualified as *white*, is qualified by the *knight* as its 'agent.' The DCP tree is shown in Figure 3.

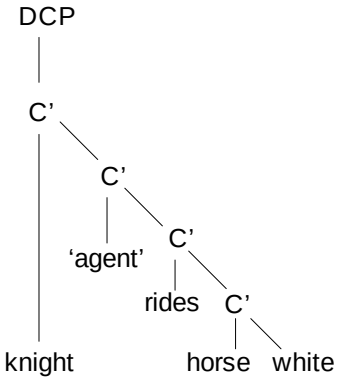

Figure 2
DCP tree of sentence “*The knight rides a white horse*” having the nominal element in the head position

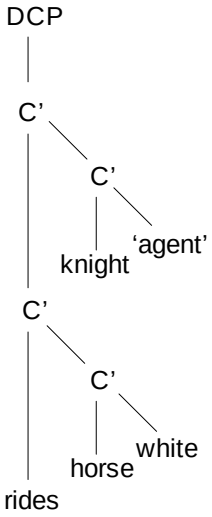

Figure 3
DCP tree of sentence “*The knight rides a white horse*” having the verbal element in the head position

Some remarks can be stated regarding the semantical difference between the two cases of the word selection in the head position. A verb phrase usually refers to some action or state, and it is in relation to the meaning of the verb that the nominal inflections are formed. Therefore, having in mind the rules about the inflectional modifications of different words, a good choice would be to select the verb for the head position in a DCP tree. On the other hand, if we are interested in developing ontologies, choosing the nominal phrase for the head position would be preferable. A nominal phrase refers in general to an object or substance. From that point of view, the substance is regarded as the fundamental basis for different

semantic properties such as qualities and actions, designated by the other elements of the sentence. Therefore, the nominative case word will occupy the head position to which all the other objects will be related as properties in the DCP tree.

The DCP tree construction is facilitated if it is put in correspondence with the X-bar schema describing the same sentence. A useful property of X-bar representation is the capability to determine the noun phrase's case. This is given by the corresponding noun phrase's governor. A governor in an X-bar tree is a NP or VP with a head or an IP node for which the head has tense information. The nominal element having the nominative case in the X-bar tree will occupy the head position in the DCP tree. We can further apply the general property of differentiated-cognition principle, and describe the meaning of the sentence "*The knight rides a white horse on the battlefield*," as follows: The *knight* is qualified as the 'agent' or the 'doer' qualified by the verb *ride*, which has the object a *horse*, which in turn is qualified by the property of being *white*, and property of location (*on*) having *battlefield* as object. In terms of formal metalanguage description, the meaning content appears as:

$$C(k, C(a, C(r, C(C(h, w), C(o, b))))), \quad (3)$$

where *k*, *a*, *r*, *h*, *w*, *o*, *b* are abbreviations for *knight*, 'agent', *rides*, *horse*, *white*, *on*, and *battlefield* respectively. The corresponding DSP tree can be completed as in Figure 4.

Considering that X-bar representation is a binary tree, it is convenient to express the meaning cognitive structure in terms of X-bar nodes. Thus, the NP with nominative case, which is the specifier of IP, is cognized as being the 'agent,' which is cognized as the V node (head of VP), which is cognized as the NP (first complement of IP), which is cognized as the PP (second complement of IP).

We have to remark the possibility to apply directly the differentiated-cognition model to the X-bar model. So, the head of VP tree is the node V, denoting the verb element *rides*. This will also be the head of the corresponding DCP tree. The specifier of VP is the NP, *the knight*, which is the qualifier of the VP node. The V node is cognized as the NP node (first complement), which is cognized as PP node (second complement). The corresponding DCP tree is shown in Figure 5. The metalinguistic description results as follows:

$$C(C(V, C(NP, PP)), C(NP, a)), \quad (4)$$

where *a* stands for 'agent' which is the qualifying property of the specifier NP.

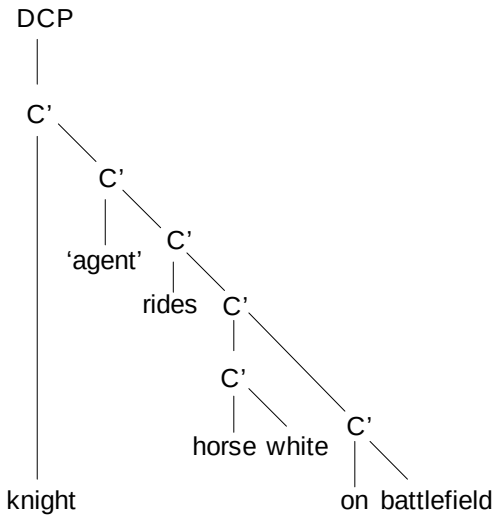

Figure 4

DCP tree of sentence "*The knight rides a white horse on the battlefield* " having the nominal element in the head position

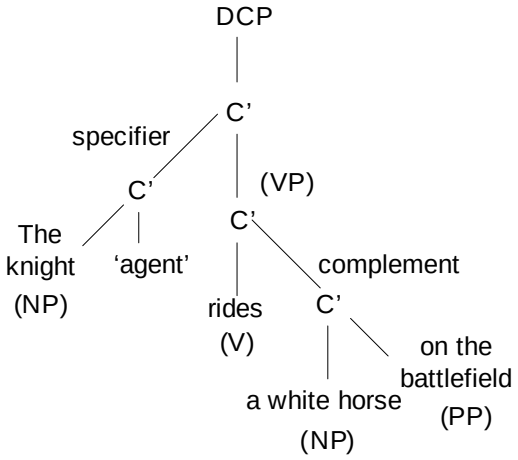

Figure 5

The corresponding DCP tree of the VP tree of sentence "*The knight rides a white horse on the battlefield,* " having the verb as the central cognized element

As we mentioned in the introductory section, our approach is based on identifying and representing thought structures or cognition states associated with language. Thus, describing the content of cognition is equivalent to describing the meaning of a sentence. Even though the thought structure which originated the linguistic

construction on the speaker part is inaccessible to the hearer, the problem is to model a procedure for information extraction from linguistic construction which is equivalent with the thought structure of the speaker. Such a procedure will objectively describe the meaning content of a sentence. In this regard, the differentiated cognition model in conjunction with the X-bar model can be successfully applied for describing the meaning content in a computational approach of language understanding. In the following section we present the way such an understanding can take place.

3 Meaning as Oneness

We started with the assumption that at least one kind of internal states is interrelated with language, or in other words that there is no cognition without the operation of the word. This is not in the sense that we have a thought and then look for a word with which to express it, or that we have an isolated word which we try to associate with a thought. Observations may lead to the fact that people do not speak in individual words. Linguistic communication is based on a meaning concept as a whole at the level of indivisible sentences. Although the individual words or even letters have meaning, the sentence is the complete form of a meaningful thought.

In defining meaning as something that must have a finite description, we postulate the concept of undivided meaning whole (UMW), which exists internally at the agent's information level. This is structured information, and may be similarly conceived as informational structure of an algorithm. UMW complies with the algorithmic description of differentiated-cognition schema. The principle behind language formation is analitic, in the sense that the whole is primary and its differentiated parts are secondary. When an agent wants to communicate, it begins with the UMW existing internally in its knowledge base. Even if UMW is a unitary information structure, it is describable rationally in terms of cognitive semantic units. This description involves a higher order language (metalanguage) such as differentiated cognition model. These semantic units are the generating principle of producing the sequence of uttered words. In order to be understood language needs to be redundant. The employ of natural language in a two-person like game involves redundancy. This redundancy as we might expect is employed in helping the receiver to correct errors and compensate for noise. When words are uttered producing different sounds in sequence, it appears only to have differentiation. Ultimately, the sound sequence is perceived as a unity and only then the word meaning, which is also inherently present in the receiver's mind, is identified. The communication of insightful knowledge may require the employment of a variety of expressions. Since the thought states of both the transmitter and the receiver are subjective mental states, we are not concerned

with how different people may experience the unitary word meaning manifestation. Our approach aims for a universal formal procedure which can lead to a description of cognition, and hence the meaning, that can be expressed when an utterance is received by a generic ideal recipient. The differentiated cognition principle can model such a universal formal procedure.

In our approach we conceive that the whole word/sentence meaning has to be inherently present in the mind of each agent. Thus, it can be explained how it is possible the UMW to be grasped by the hearer even before the whole sentence has been uttered. The sounds which differ from one another because of difference in pronouncement cause the cognition of the one changeless UMW without determining any change in it. Sometimes, reasoning mechanisms may have to be applied to the components of the sentence so that the cognition becomes sufficiently clear to make possible the perception of the meaning-whole.

The differentiated cognition model when applied to a sentence satisfying the semantic bearing criteria can lead to a compressed description of UMW type, which can be matched against the recipient previous experience, having the result the meaning recognition or understanding.

Conclusions

We started from the assumption that at least some of the internal states are interrelated with language. One such kind of internal states is cognition, and is related with meaning. Cognition appears as an UMW having a finite description, and is also is the generating principle of producing the sequence of words in the transmitter. However, even if the individual words are meaning-bearing elements, only the sentence as a whole takes the form of a structured thought. The meaning is thus the description of the cognitive state in terms of objects and their qualifying properties. Therefore, a sentence is a cluster of meaningful words capable to generate the cognitive state of UMW in an ideal recipient. The same UMW is the generating principle of producing the sequence of words, having a meaning, in the transmitter, and is also the result of a process of extracting meaningful information from that sentence in the receiver. This meaning content can be extracted by an ideal recipient applying the model of differentiated-cognition in a computational approach of language understanding.

References

[1] R. J. Stainton: Philosophical perspectives on language. Peterborough, Ont., Broadview Press, 1996

[2] W. G. Lycan: Philosophy of Language: A Contemporary Introduction. New York, Routledge, 2000

[3] J. Collins: Truth Conditions Without Interpretation, Sorites, ISSN 1135-1349, Issue #13, October 2001, pp. 52-71

[4] M. Greenberg and G. Harman: Conceptual Role Semantics. Oxford Handbook of Philosophy of Language, Ernie Lepore, Barry Smith, eds., Oxford University Press, 2005

[5] A. J. Fodor: Psychosemantics: The Problem of Meaning in the Philosophy of Mind. Cambridge, Massachusetts: MIT Press, 1987

[6] R. Rucker: Infinity and the Mind. Princeton University Press, New Jersey, 1995

[7] M. Crisan: Towards a Model of Language Understanding. 2nd Romanian-Hungarian Joint Symposium on Applied Computational Intelligence SACI 2005, pp. 207-220

[8] M. Crisan: Explaining Sentence-Meaning in Terms of Differentiated-Cognition, Periodica Politechnica, Transactions on Automatic Control and Computer Science Vol. 50 (64), 2005, pp. 49-54