

The Relevance of Language for the Problem of Representation

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Abstract. The present contribution deals with the relationship between representation and language that becomes more relevant if we do not intend the process of forming internal representations of reality but rather the representative function of language. This allows the categorization and the sharing of categories; for this reason, it entails important results also for the Semantic Web. Starting from an overview on the contemporary debate in Philosophy and AI, we draw attention on some very interesting ideas proposed by Harnad in response to the challenge of Searle about the “symbol grounding problem”.

1 INTRODUCTION

The notion of “representation” is at the basis of a lively debate that crosses philosophy and artificial intelligence. This is because the comparison starts from the analysis of “mental representations”. In the contemporary debate appears a distinction between the “symbolic” and the “connectionist” paradigms in AI [1]. This distinction is useful to highlight two different ways of explaining the notion of representation in AI. The task to consider the similarity between human and artificial representation could involve the risk of skepticism about the possibility of “computing” this mental capacity. If we consider computationalism as defined in purely abstract syntactic terms then we are tempted to abandon it because human representation involves “real world constrains”. But, a new view of

computationalism could be introduced that takes into consideration the limits of the classical notion and aims at providing a concrete, embodied, interactive and intentional foundation for a more realistic theory of mind [2]. We would like to highlight also an important and recent debate on “digital representation”[3] that focuses on the nature of representations in the computational theory of mind (or computationalism). The starting point is the nature of mental representations, and, particularly, if they are “material”. There are authors who maintain that mental representation are material [4] others think that thought processes use conventional linguistic symbols [5]. The question of digital representation involves the “problem of physical computation [6] as well as the necessity of the notion of representation [7] so that we only have the problem of how to intend the very notion of representation [8]. But, there is also the possibility of understanding computation as a purely syntactic procedure or to include “every natural process” in a “computing universe” [9].

The problem of representation of reality is at the center of researches in the field of Knowledge Representation. This is the field in which formal ontology shows its relevance [10]. Basti proposes a theory of singular reference in the field of theoretical formal ontology that applies to theoretical computer science. He suggests an application of the Quantum Fields Theory that models brain-environment dynamics. The relevance of sorts of classifier strictly related to the functioning of human language is underscored by the Semantic Web community. According to Peroni, the Semantic Web

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community has produced a set of complimentary languages and tools for developing, maintaining, using and sharing domain models for Software Engineering, amongst other purposes. At the core are the languages OWL and RDF Schema, OWL being optimized to represent structural knowledge at a high level of abstraction. Domain models encoded in OWL can be uploaded on the Web and shared among multiple applications. OWL is supported by an unambiguous dialect of formal logic called *Description Logics* [BHS 2003]. This formal underpinning makes it possible to exploit intelligent reasoning services such as automatic classification and consistency checking. These services can be used at build-time and therefore facilitate the construction of reusable, well-tested domain models. Reasoning services can also be used at runtime for various purposes. For example, this makes it possible to define classes dynamically, to re-classify instances at runtime and to perform complex logical queries. In addition to their foundation on logics, OWL and RDF Schema operate on similar structures to object-oriented languages, and therefore can be effectively integrated with traditional software components. [11]

2 A FREGEAN BACKGROUND

To start with a philosophical account of the use of language, I would recall some ideas from Frege. Frege inherits the Kantian conception according to which there could not be any combination of ideas unless there were already an original unity that made possible such combination. According to Sluga [12], Kant anticipates the Fregean doctrine of concepts: “Concepts, as predicates of possible judgments, relate to some representation of a not yet determined object. Thus the concept of body means something, for instance, metal, which can be known by means of the concept. It is therefore a concept solely in virtue of its

comprehending other representations, by means of which it can relate to objects. It is therefore the predicate of a possible judgment, for instance, ‘every metal is a body’ “. In the *Begriffsschrift* we can find an anticipation of the notion of judgment presented in the later work *Function and Concept*. The main point is that functions, concepts and relations are incomplete and require variables in their expression to indicate places of arguments. To establish a correspondence between function and concept Frege maintains that the linguistic form of an equation or identity is an assertoric sentence. It embeds a thought as its sense or, more precisely, we can say that it “raises a claim” to have one. Generally speaking, the thought is true or false namely it possesses a truth-value that could be considered as the meaning of the sentence like the number 4 is the meaning of the expression “2+2” and London is the meaning of the expression “the capital of England”.

The assertoric sentences can be decomposed into two parts: the “saturated” and the “unsaturated” one. For instance, in the sentence “Caesar conquered Gaul” the second part is unsaturated and it must be filled up with a proper name (in our case Caesar) to give the expression a complete sense. In *Concept and Object* Frege clearly clarifies the nature of the denotation of a predicate. A concept is the denotation of a predicate.

Searle’s account presents a step beyond Frege’s descriptivism because in order to give weight to propositions and their intentional contents we must distinguish them from the sense [13]. The sense of a referring expression is given by the descriptive general terms entailed by that expression but the sense is often not sufficient to communicate a proposition. Consequently, it is the utterance of the expression “in a certain context” (namely a pragmatic context) that communicates a proposition. For example, the expression “the dog” has the descriptive content entailed by the simple term “dog”; this very

content is not sufficient for a successful reference which also requires the communication or the possibility to communicate a uniquely existential proposition (or “fact”, e.g. “There is one and only one dog barking on the right of the speaker and it is in the field of vision of both speaker and hearer”). The classical formalization ($\exists x fx$) could be used to mean that “the predicate f has at least one instance” instead of “Some object is f ”. The meaning of this option does not establish a correspondence between the original proposition and its revised existential formulation; rather it says that the circumstances in which the one is true are identical with the circumstances in which the other is true.

According to Searle, a belief is a “representation” (not in the sense of having an “idea”) that has a propositional content and a psychological mode: the propositional content or intentional content determines a set of conditions of satisfaction under certain aspects and the psychological mode determines the direction of fit the propositional content. “Conditions of satisfaction are those conditions which, as determined by the Intentional, must obtain if the state must be satisfied” [14].

In this context, it is crucial to distinguish between the *content* of a belief (i.e. a proposition) and the *objects* of a belief (i.e. the ordinary objects). For instance, the content of the statement or belief that de Gaulle was French is the proposition that de Gaulle was French. The statement or belief is not directed at the proposition but is about de Gaulle. It represents him as being French by virtue of the fact that it has “propositional content” and “mode of representation”.

The process of representation functions because of a Network of other intentional states and against a Background of practices and pre-intentional assumptions that are neither themselves Intentional states nor are they parts of the conditions of satisfaction of Intentional states [15]. The intentionality of mental states represents an original interpretation of the

Fregean account of beliefs. A further step in the analysis is the distinction between Intentionality-with-a-t and Intentionality-with-a-s. In this case a belief in Intentional-with-a-s if does not permit to determine its extension i.e. substitution *salva veritate*. For instance, if I say “Vic believes that Rossella is an Irish setter” I simply report Vic’s belief but I cannot commit myself to its truth namely the fact that Rossella is an Irish Setter. Obviously, Vic’s belief is extensional and Vic is committed to its truth (it is Intentional-with-a-t).

Let’s now briefly refer to a difference between Frege’s and Searle’s accounts of belief. Standardly, beliefs are introduced by a “that” clause as in our example (1) “Vic believes that Rossella is an Irish Setter”. This report is different from the statement (2) “Rossella is an Irish Setter”: 1 is intensional whether 2 is extensional. A fundamental difference between the two forms of sentence is that in a serious literal utterance 2 is asserted while in a serious literal utterance of 1 the proposition is not asserted.

Searle sets up conditions for the adequacy of intensional reports of Intentional states [16]:

1. The analysis should be consistent with the fact that the meanings of the shared words in pairs such as 1 and 2 are the same, and in serious literal utterances of each they are used with these same meanings.
1. It should account for the fact that in 1 the embedded sentence does not have the logical properties it has in 2, viz., 2 is extensional, 1 is intensional.
2. It should be consistent with the fact that it is part of the meanings of 1 and 2 that, in serious literal utterances of 1, the proposition that Rossella is an Irish Setter is not asserted, whereas in 2 it is.
3. The analysis should account for other sorts of sentences containing “that” clauses, including those where some or all of the

logical properties are preserved, such as “It is a fact that Rossella is an Irish Setter”.

4. The analysis should apply to other sorts of reports of Intentional states and speech acts which do not employ “that” clauses embedding a stance but use infinitives, interrogative pronouns, the subjunctive, change of tense, etc. Furthermore the analysis should work not just for English but for any language containing reports of Intentional states and speech acts (as for example “Tess wants Rossella be an Irish Setter”).

The first condition could not be accepted from a Fregean perspective because, according to Searle, when we have sentences containing “that” clauses we have always the same meanings of the shared words and a variation of the illocutive act (“to believe that”, “to say that”, etc.). Nevertheless Searle’s account respects Frege’s notion of belief. In the case of “to believe that...” sentences do not have the so called “direct *Bedeutung*” but they have “indirect *Bedeutung*”. This fact means that the truth-value can be assigned only to the second thought i.e. the thought of the subordinate sentence.

The background as Searle describes it and the very notions of Intentionality of beliefs have no normativity in establishing whether an individual belief is “true” in a strong sense, as something that can be shared by different people. According to this thesis, our second claim is that common beliefs as true beliefs are possible only in an intersubjective context in which individual descriptions can overlap by referring to the same object under precise substitutional rules.

According to Frege, the same object or *Bedeutung* can be thought in different ways namely the same object can have different “senses”. Frege’s famous example of the proper names or descriptions such as “Venus”, “Morning star” and “Evening star” is however to

be considered as valid for the explanation of common beliefs as “true” beliefs. For instance, A thinks Venus as the Morning star and B thinks Venus as the Evening star with the result of a problem of communication; the problem is solved because the two descriptions have the same meaning i.e. Venus and surely it is possible to establish whether the two descriptions work for the object to which they refer.

Thoughts can be true or false but sentences do not express them “randomly”. Sentences express thoughts as related to contexts of use in which they acquire their truth-value i.e. they are true or false. For instance the sentence “That is a funny play” can be true or false depending on the context of use. We can grasp thoughts but Frege does not present an analysis of the “grasping” because he thinks that this implies a psychological order of explanation. Searle rather gives an account of the grasping through his brilliant account of the functioning of background based on intentionality. We can therefore show the complementarity between the description of the functioning of the cognitive grasping of the content of beliefs and the “normative” objective content that represent the ground of shared beliefs.

3 REPRESENTATION AND LANGUAGE

I would mention two philosophical approaches that cross philosophy and AI by making some Fregean ideas more useful for machines.

Let me briefly refer to some ideas from the so-called “analytic pragmatism” [17]. I think that it represents a view that clarifies what abilities can be computationally implemented and what are typical of human reasoning. The intentionality of conscious mental states is described here according to a set of deontic states (commitments and entitlements) and deontic

attitudes (recognition and attribution of deontic statuses).

The model is based on [18, p. 39]:

- basic practices that are “sufficient” to “deploy” a vocabulary
- a vocabulary that “specify” the set of practices-or-abilities
- the sufficiency of a set of practices –or –abilities that can be elaborated into another, by a set of algorithmic abilities that implement that practical elaboration
- the sufficiency of one vocabulary to “characterize” another (the relation of being a direct or immediate semantic or syntactic metavocabulary).

In Brandom’s terms: “Transducing automata are more than merely syntactic elaborating engines because the stimuli they can respond to and the responses they can produce are not limited to symbol-types (or sign-types). Depending on the ‘alphabet’ of stimulus- and response-kinds they elaborate, however, they can also manipulate symbols. But they also allow us to think about symbols in a new way: still not representationally, not yet semantically, but not just syntactically either. For we can think of symbols generically as anything that can both be read and written, that is, recognized and produced. In this broad sense, appropriate to transducing automata, anything in the intersection $S \cap R$ of S and R can be used as a symbol: any stimulus-kind, instances of which the system can produce as responses” [19, p.39].

The description of the practices-sufficiency gives rise to a “mechanical” process like a sort of “rule following” that could also characterize, for example, rituals that possess a certain

vocabulary. In this case we have three vocabularies: V_1 emerges from basic practices (performance of rituals), V_2 characterizes V_1 i.e. is a syntactic or semantic metavocabulary (describes what we are doing in the performance of certain rituals) and V_3 specifies what the system is doing according to certain rules (specifies the rules that govern the performance of rituals). Obviously, the result is that what we can elaborate is a procedure that does not grasp the “content” of individual mental states namely there exist aspects of them that are not captured by the mechanical process (the first person ontology). The practices that can be artificially elaborated are sufficient i.e. “PP-sufficient” to deploy a particular vocabulary (in our case the vocabulary that characterizes a certain ritual). But we can ask: are there any practical abilities that are *universally* “PV-necessary”? In Brandom’s words: “inferential practices are PP-necessary components of every autonomous discursive practice, hence PV-necessary for the deployment of every autonomous vocabulary, hence PV-necessary for the deployment of every vocabulary whatsoever. They are universally PV-necessary” [20, p. 41].

Inferential practices are typical of the practice of “asserting” that is different from other kinds of broad “linguistic practices”. Assertional practices are typical of human beings and they are structured by material inferences, namely by the commitments and the entitlements implied by concepts and made explicit by conditionals [21, chap. 3]. This thesis implies that inferential practices are necessary to deploy every vocabulary we use in our ordinary life. In this case we ought to concentrate on conditionals governed by material inference such as “If Vic is a dog then Vic is a mammal” or “If this ball is red then it is not green”. The validity of a material inference is given by the correct use of concepts such as “dog” and “mammal” that is given by the commitments and the entitlements entailed by the concepts.

I think that Brandom's argument allows interpretations, which demonstrate that also the inferential dimension of human reasoning can be computationally elaborated [22].

4 A TURING ROBOT

We can also show the relevance of language for a Turing Robot to steal categories far beyond the temporal and spatial scope of its sensorimotor interactions and data [23]. Harnad proposes the "narrow hybrid approach" to symbol grounding on the basis of sensorimotor interactions with the distal objects of which they are the proximal projections. This sensorimotor capacity is a robotic capacity and aims at capturing instrumental responses or the arbitrary names that successfully sort them according to what is adaptive for the hybrid system. The essential point of Harnad's proposal is the acquisition of categories by "symbolic theft". Categories can be acquired by "nontoil" through the receipt of verbal information under the conditions that the symbols in the verbal message are already grounded (by sensorimotor toil or indirectly and recursively by previous grounded verbal messages) and that there is someone who already possesses the category and is ready to share it with you.

Harnad makes two important suggestions:

1. Successful sorting capacity must be based on detectable invariance and
2. The invariance can be learned via experience or via hearsay.

The role of language becomes very clear if we consider a useful example: the mushroom/toadstool case [24, p. 153]: "In a mushroom world I could earn these to important survival categories the hard way, through honest toil, sampling the sensorimotor projections and

trying to sort them based on feed back from sometimes getting sick and sometimes getting nourished. Assuming the problem is soluble, that is, that projections are successfully sortable, then if I have the requisite learning capacity, and there is enough time in the day, and I don't kill myself or die of hunger first, I will sooner or later get it right, and the basis of my success will be some sort of invariance in the projections that some internal mechanism of mine has laboriously learned to detect. Let's simplify and say that the invariant is the Boolean rule 'if it's white and has red spots, it's a toxic toadstool; otherwise it's an edible mushroom'".

Naturally, life becomes easier namely without toil and risk if one could be informed that a "toadstool" is a "mushroom" that is "white" with "red spots". Clearly, one has to know what "mushroom" and "white" and "red" and "spots" were, but, symbolic theft is recursive, though not infinitely regressive (the vocabulary of theft must be grounded directly in honest toil and/or Darwinian theft).

Things become more difficult in the case of the categorization, for instance, of chairs, bears, games and goodness namely the problem is to individuate the shared categories of the sensorimotor projections of all the members of each of these categories (the "social" dimension of meaning). Let's consider Harnad's "Peakaboo Unicorn"[25, p.154]: "A Peekaboo Unicorn is a Unicorn, which is to say, it is a horse with a single horn, but it has the peculiar property that it vanishes without a trace whenever sense or measuring instruments are trained on it. So not just in practice, but in principle, you can never see it; it has no sensorimotor projections. Is "Peakaboo Unicorn" therefore a meaningless term?" It is a meaningful term like "Toadstool" or "Zebra" in the sense that we can give a linguistic description of them. The sentences "a toadstool is a white mushroom with red spots" and "a

Zebra is a horse with black and white strips” provide the way you can learn what “toadstool” and “zebra” mean without having to find out the hard way. Again, we need the terms of the sentences to be grounded directly or indirectly. In the case of the Peekaboo Unicorn, it is “horse”, “horn”, “sense”, “measuring instrument” and “vanish” that must be grounded.

Harnad’s example demonstrates that language provides resources to give meaning also to abstract entities and this discussion provides arguments for the implementation of “representative” capacities in artificial agents. The “symbol grounding problem” reveals the real challenge for AI (according to the Turing-Test scale) as grounding requires an internal mechanism that can learn by both sensorimotor toil and symbolic theft. [26] A Turing Robot unlike an encyclopedia is “grounded” namely the connection between its symbols and what they are interpretable as is not mediated by an external interpreter. Language has a functional value in humans and robots. It allows it to rely on its proximal projections and the mechanism in between them for grounding.

5 CONCLUSION

Knowledge plays a relevant role for categorization and, nowadays, there is a strong effort to promote communication among experts and users. Obviously, there is a problem for reaching this scope if we consider only an approach based on object. In this case it is difficult to clearly express the important semantic correlations with other objects and with elements from other disciplines. [27]. But the Semantic Web presents an alternative open to interoperability on both technological and semantic levels. But, only humans can combine knowledge coming from different sources.

In recent years has been affirmed an approach to information in which users play an

active role and they are knowledge producers themselves. The Semantic Web opens a fascinating and new scenario, in which the Web represents an enormous deposit of knowledge and the information comes from links among data memories from different points of the web. Ontology based on an interoperable knowledge representation provides a fruitful model for web research and browsing. There are some basic ontologies such as CIDOC-CRM that tries to adequate to the mental model which express the interests of the users and implement suitable mechanism of navigation [28].

The Semantic Web constitutes the context in which ontologies can be fruitfully applied. We mentioned two philosophical attempts to find models of knowledge representation based on the use of language and its logical structure. They focus also on the social dimension of knowledge representation and can therefore express the main goal of the Semantic Web research. The problem is to formally represent knowledge as it becomes shareable and ready to be used by humans and machines.

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