On the Realism of Human and Machine Representational Constraints: A Functionalist Account on Cognitive Ontologies

Zarebski David [1]

Abstract. This papers is concerned with the primitive constraints on Information Systems' and Humans' representations of the reality. We intend to support the idea that a proper understanding of what is at stake in Information Systems Ontologies (ISO) and its relation with the representational constraints in human cognition may solve a recent issue about the status of philosophical intuitions in metaphysics.

Introduction

Information comes with degrees of generality. While some information, like the location of my bike at a certain time is factual, the fact that, as a physical object, my bike *has to* occupy a certain location *at any time* are structural ones. One historical account on these structural information is to be found in Aristotle's theory of *categories*. Initially understood as the real, mind independent primitive components of the world, collections of categories – a.k.a. *ontologies* – have also been a useful tool in cognitive sciences and data engineering for the last three decades.

Despite many interactions, the very meaning of *ontologies* varies across these fields, for they do not share the same goal – theoretical vs practical – the same domain generality nor the same attitude toward the correlate of categories – physical world [1], human cognitive structure or electronic information structure. Most of the interactions between these fields – see fig.1 – consist either in explaining how the human cognitive structure may affect metaphysical practices (*meta-metaphysics*) or why information systems ontologies (ISO) should be based on the results of formal philosophy – as explicitly stated by Andrew Spear [2].

However, the possibility that some of the reflections around ISO might solve deep metaphysical issues has not been taken for granted. We would like to suggest how reflexions around ISO may disentangle a purely philosophical and speculative issue, namely the putative incompatibility of *ontological realism* and *naturalized metaphysics* as lately advocated by Chalmers [3] and Allen [4]. More precisely we will focus on Alvin Goldman's variant of naturalized metaphysics [5, 6] we will call the *Cognitive-Sciences-based Meta-Metaphysics* (CSMM).

[1] University Paris 1 Pantheon Sorbonne, IHPST France, email: zarebski-david@gmail.com

[2] "*The ontological problem for computer and information science is thus identical to many of the problems of philosophical ontology, and it is becoming more and more clear that success in the former will be achievable, if at all, only by appeal to the methods, insights and theories of the latter.*" [2] p7

After a clarification on the different meaning of *ontologies* (section 1) and what is to be meant by CSMM (section 2), we will present Allen's and Chalmers' arguments for this incompatibility (section 3). Finally, section 4 provides arguments for a machine-based approach on this issue and explores its consequences for the different varieties of realism.

1 Ontology, Ontologies: the structure of reality and its representations

Though this partition might be sharp compared with actual multi-disciplinary accounts, there are three ways of conceiving ontologies. They can be either conceived as the mind independent structure of the reality to be investigated by philosophy and formal ontology [7, 8] – section 1.1 – as the structure of the human representation of the world explored by cognitive sciences – section 1.2 – or as the structure of knowledge representation enquired by data engineering – section 1.3.

1.1 The philosophical realist account on categories

Ontologies have first been philosophical theoretical objects for centuries. Initially understood as real primitive components of the world, typical categories ontologies are composed of include

individuals or time-proof entities (say Fritz, my cat)
tropes properties bared by individuals (say the unique color of Fritz)
universals or natural kinds (cats, tables)
relations

Though this nomenclature might not be an exhaustive one, it is however complete enough to present some of the key features of philosophical ontologies (PO). First of all, PO are domain general. This means that the same scheme holds for both "*Fritz the cat is on the table*" and "*electron 1 is attracted by electron 2*": two individuals which instantiate natural kinds hold a certain relation. This has a crucial influence on the kind of inferences to be made from the premisses, for this level of abstraction does not inform on, say factual details about feline life or sub-atomic particles, but rather synthesizes common characteristics of individuals as the fact that individuals are countable entities – e.g. one cat and two electrons.

Finally, it should be acknowledged that the tacit realism together with the putative domain generality of PO imply that *there must be only one* genuine Ontology. Let us call this principle the *uniqueness assumption* which states that the existence of certain types of entities – e.g. Universals as in XIIIth century's problem of Universals –

is not a matter of whether we could *conceive*, *make sense of* or *explain* a world without it but whether there is a *fact of the matter* about it. These metaphysical issues should be carefully distinguished from epistemological ones, for what is at stake is not whether there are such things as *cats* or whether *Fritz* or *Gandalf* exist but whether reality is fragmented into different *kinds of beings* with their respective properties.

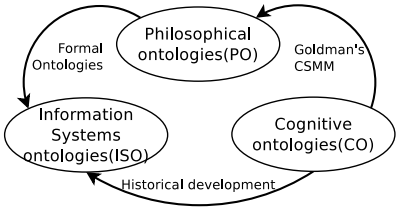

Figure 1. Usual interactions across the different meanings of Ontologies

1.2 Conceptualism and the human cognitive structure

A challenging tradition we might call *Conceptualism* has stressed the necessity to investigate our conceptual structure rather than the world. This designation is a broad one, for Conceptualism this way conceived includes account as different as the kantian transcendental idealism or Strawson's *Descriptive Metaphysics* which "[...] *is content to describe the actual structure of our though about the world* [...]" [9].

Nonetheless, despite the great variability of philosophical and psychological accounts, the core idea might be stated as follows. Our mental – i.e. perceptual or conceptual – representations of the world follow some primitive rules which are the cognitive counterparts of PO. As a perceptual example, to acknowledge that "*Fritz the cat is on the table*" is to be able to split this complex object in two independent individuals rather than their mereological sum – i.e. some table-cat. In other words, being able to perform such a task implies to possess a *Cognitive Ontology* (CO). Before presenting cognitive sciences based account on conceptual structures, we would like to avoid a common confusion about the meaning to be given to "*Categories*" in cognitive sciences.

Categories and cognitive domains "*Categories*" have sometimes been used in developmental psychology to denote the psychological counterpart of natural kinds as did Lakoff [10] Keil [11] or Medin's folk-biology [12, 13]. Though relevant as descriptions of the kind of constraints on our representation of natural kinds, we intent to avoid such a "*rampant ambiguity about categories*" as Hacking expressed it [14].

Cognitive ontologies, common sense and intuitions The way we will understand "*Categories*" in cognitive sciences is close to Barry Smith's perspective on the so called *Common Sense Ontology* [15]. According to Smith, the primitive cognitive processes, study of which might be labelled as *Cognitive Metaphysics* [16], are responsible for a great number of pre-theoretical and intuitive systems of belief such as:

Folk Physics the putatively innate system of knowledge of solid-based physical phenomenon [17] – see also [18]

Common sense the fact that, as early expressed by Köhler, our perception "[...] *consists first of all of objects, their properties and changes, which appear to exist and to happen quite independently of us* [...]" [19] based on

Gestalt principles driven by visual features such as good continuation, similarity, or symmetry – see fig.2

First of all, it should be pointed out that CO are neutral toward realism. Whether the existence of a particular cognitive mechanism implies some mind-independent property of the world [20] or not [12, 21] does not impact on the descriptive practice nor our cognitive scheme. Secondly, CO and PO differ in their respective domains, for CO apply to the ecological context of middle sized entities – i.e. Fritz rather than the particles he is composed of.

Another useful distinction to understand in which sense some primitive cognitive components may be labelled as categories lies in the notion of *meta-level categories* [22]. While some psychological enquiries focus on the *content* of human representation, the primitive components involved in CO concern more general phenomenons such as my criterion for individuation of objects (individuals) together with their general properties – being re-identifiable, countable, the bearers of accidental properties – or the general structure of the representation of natural kinds rather that the actual content of concepts such as "*cats*" or "*tables*". To put it in other words, psychological investigations on CO are concerned with the general stratification of our representations of the world we live in [3].

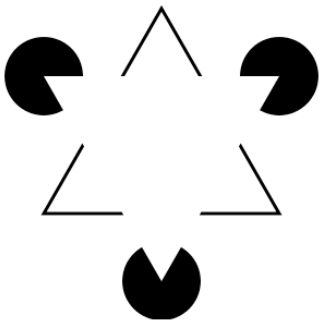

Figure 2. Kanizsa's triangle

Finally, the relation of this field with Artificial Intelligence should be acknowledged, for some attempts to formalize the most general features of common sense representations were meant to be implemented as axioms for automatic utterance production by languages such as PROLOG or LISP – see [24, 25] for folk physics.

1.3 Ontologies as electronic information structure

Another way of conceiving ontologies concerns knowledge representation in information systems (IS). To illustrate the way categories intervene in information systems, lets say that I need to add in a

[3] "*And this recognition leads straightway to one of the fundamental thesis of ontology: to be is to be an item of a certain type or kind*" [23] p.26

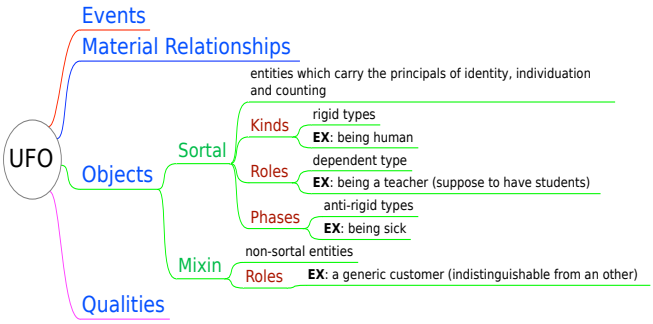

Figure 3. Examples of categories in the *Universal Formal Ontology* (UFO Guizzardi [28])

certain data base the fact that Fritz the cat is on the table. To perform it in an *efficient way*, I could type every components of this fact so as to indicate what they have in common with the other entities of my database. For instance I could follow the categories of the *Descriptive Ontology for Linguistic and Cognitive Engineering* (DOLCE [16, 26]) and use different types for Agentive Physical Object (APO e.g. Fritz) and non agentive ones (the table). Likewise, I could type the relation "*being on*" as an endurant-endurant relation – i.e. a relation which holds between individuals.

But before we define *efficiency* in the context of IS, we should highlight the kind of IS we shall focus on, namely machine-based or *automated information systems* [27]. Though the reflections around information retrieving, fitness or realism induced by the adoption of a particular ontology extends to human agents, we are here interested in the core, artificial intelligence-based, notion of IS: the way the adoption of a certain ontology impacts the operations of an inference engine. In such a context, relevance of Information Systems Ontologies (ISO) should be understood by means of the computational cost induced by information retrieval for an expert system.

From this point of view, ISO share some common features with CO. First of all, ISO are also domain specific though in a plural fashion, for different ontologies have been proposed for many different domains from geographical representations [31, 32] to biomedical data [27] or even philosophical positions [33]. However, some research around formal ontology has also developed *upper level ontologies* – see figures 3 and 4 – supposed to be both *domain general* and efficient on a pragmatical point of view. Because of their similarity with CO categories [15], we will focus on this kind of ISO in the rest of the article.

Finally, as CO, ISO are also neutral toward realism and its relation with common sense. While authors have advocated a purely computational argument for ontological pluralism, the ideas that the realist structure of information impact the reliability of computer-based IS tasks [34] despite its possible contradiction with common sense have also been defended [4].

2 Naturalized and Meta-Metaphysics

Though these levels are often present in the same thesis, one should distinguish metaphysical – a.k.a. first order – from meta-metaphysical claims. While the former ought to answer the traditional question "*What is there?*", the later ask about the various reasons or justification of the former. As an example of this dichotomy, while Quine advocated for an individual-based metaphysics [36], his meta-metaphysics is the well known thesis that we are ontologically committed to the kind of entity our best scientific theories quantify over [37].

2.1 The issue of intuitions' epistemological status

Among the meta-metaphysical choices to be made, one must judge the legitimacy of intuitive methods in metaphysics. Another related question to be raised is whether metaphysics should use the methodology or the results of empirical sciences – i.e. whether metaphysics should be *naturalized*. Even if *Naturalized Metaphysics* is often defective toward the use of intuitions in metaphysics [38], the Cognitive Science Meta-Metaphysics (CSMM) supported by Goldman provides a positive role for intuitions best illustrated in [39]. Broadly, Goldman's CSMM can be summarized in three points.

- α Intuitions do play a role in first order metaphysics [39]
- β The origins of these intuitions are to be found in the most primitive features of our common sense and are thus investigable through cognitive sciences [5]
- γ These intuitions remain reliable enough to support some varieties of realism

To develop further more, the point α is a parsimonious one, for it has been acknowledged for a long time by both detractors [40, 41] and partisans of intuitive argument and methodology for first order metaphysics [42, 43]. As a kind of meta-metaphysics, points β is less classical and deserve an illustration. Metaphysical approaches to event individuation do not agree about the identity of following events

1. Boris pulling the trigger
2. Boris firing the gun

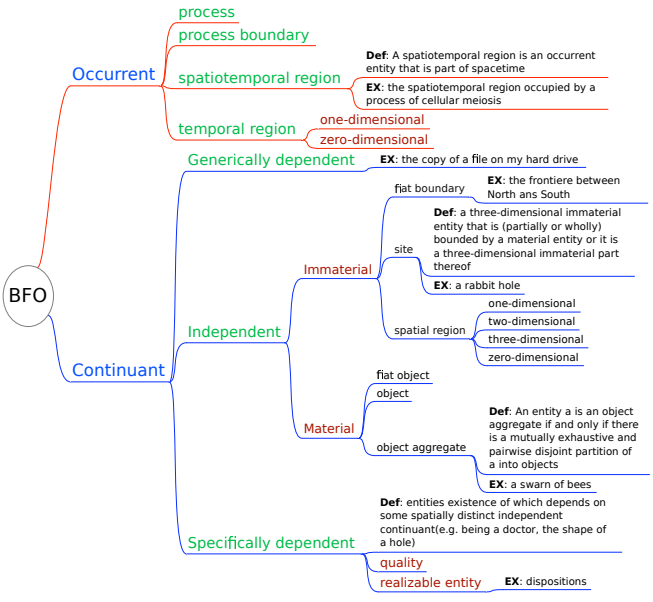

Figure 4. Examples of categories in the *Basic Formal Ontology* (BFO Smith [29, 30])

[4] "*the primary concern of knowledge engineering is modelling systems in the world, not replicating how people think*" [35] p.34

3. Boris killing Pierre

While the spatiotemporal based *unifier approach* [44, 45] would comprehend 1 2 and 3 as one and the same event, the *property exemplification view* [46, 47, 48] will distinguish these events based on the fact that firing a gun differs from killing somebody – one could well fire a gun without killing and *vice versa*. Goldman [5] suggests that the two different intuitions which support these two approaches might correspond to different *format of mental representations* of events. Alongside with the individuation of objects, the empirical investigations on the individuation of event suggest that, while children tend to use spatiotemporal criterion in both tracking based [49] and counting based experiment [50], they start to develop a kind of membership strategy which prefer to count as event goal oriented actions rather than their temporally discrete sub-actions [51].

Though Goldman's account in [39] does not explicitly mention it, the kind of primitive representational components involved in metaphysical intuition are interestingly similar with those responsible for CO as understood earlier [5, 52, 6]. The dependencies of metaphysical intuitions toward these formats of representation is explicitly endorsed by Goldman who concludes for a case of ontological pluralism which seems *prima facie* incompatible with the tacit ontological realism of PO[5].

2.2 Goldman's defence of intuitions

Yet, to come to point γ, Goldman is nonetheless committed to some kind of realism. The previous case was a case where grounded strong intuitions contradicted each other. But had these intuitions converged, would have they allowed stronger assumptions? We would like to present a Goldman defence of intuitions.

First of all, it should be acknowledged that Goldman agrees that the ultimate aim of metaphysics is to investigate mind-independent entities[6]. The question is whether intuitions are a good tool to do it. As we saw, intuitions may be contradictory. However, it is precisely the job of cognitive sciences to disentangle the most primitive components of our conceptual schemes so as to distinguish genuine from apparent or language-based contradictions. As stated in Goldman's answer to Kornblith's critique about universals [53, 54], this methodology does not rule out the possibility to move from individual to shared, embodied concepts[7].

> Although naturalistically-minded philosophers are understandably suspicious and skeptical about intuitions and their evidential *bona fides*, here we have a satisfying resolution to the challenge from naturalistic quarters, a resolution that copes straightforwardly with existing evidence of interpersonal variation in intuitions. [39] p.16

However, despite the facts that i) Goldman is known for his reliabilist account of epistemic justification of belief [55], ii) explicitly endorses the idea that our most robust cognitive mechanisms do provide belief about the external world and iii) advocates that their justification lies in their causal relation with the psychological processes they are produced by[8], the idea that these shared mechanisms provide evidence for a certain mind-independent stratification of reality – e.g. the existence of different kinds of being such as individuals, properties, relations among universals, *etc* – is not detailed enough.

To put it in other words, Goldman's view on ontological realism remains dependent on his adaptationist conception of truth *modulo* human resources and is thus exposed to the same limitations of *naturalized epistemology* which was early acknowledged by Levine [56] and Putnam [57]. Nonetheless, Goldman advocates *a priori* justification of intuitions together with their compatibility with the naturalist framework [9] by stressing the *evidence-conferring power of intuitions* when performed in a *third person conceptual investigation* – i.e. cases where the philosopher *simulates* what would be the intuitions of anybody else.

3 CSMM and Ontological Realism Putative Incompatibility

The idea that the existence of robust categories as understood by CO entails or provides evidence for their real counterparts in PO raises some difficulty. Here, we would like to present two issues lately raised in the literature.

3.1 The Ontological limitations of Naturalized Metaphysics

First off all, it has been lately suggested by Allen [4] that Naturalized Metaphysics in general, because of its very methodology, cannot meet the requirements for ontological realism. In a nutshell, because Naturalized Metaphysics share its methodology with science – i.e. a justified explanations based enquiry – and that it is known that different theoretical commitments could be equally justified, Naturalized Metaphysics could not fulfil the *uniqueness assumption* induced by PO realism[10]. As an example of the ontological plurality induced by the naturalistic framework, it has been argued [58] that an ontology can avoid the category of individuals given some adjustments on tropes. From a purely empirical point of view, despite the different ontological commitment, these bundles of tropes behave the same way as individuals.

As a kind of Naturalized Metaphysics, Goldman's CSMM is supposed to suffer from the same incapability to choose one ontology over another given that, as we presented it in section 2.1, the existence of competing mechanisms – a.k.a. format of mental representation – rules out the possibility to choose between two competing ontologies:

> There seems to be no point at which a theory chosen in this manner puts us in better epistemic contact with the ontology of the natural world than any of the rejected candidate theories do; there seems to be no reason why intuition would happen to begin with knowledge about the objective nature of the world, or else why this systematized reflection should result in such knowledge. [4] p.227

[5] "*The best solution is to countenance two metaphysical categories of events, EVENTS 1 and EVENTS 2. This is how cognitive science can play a role in the conduct of metaphysicalizing.*"[5]

[6] "*Metaphysics seeks to understand the nature of the world as it is independently of how we think of it.*"[5]

[7] "*I am not saying that the analysis of personal concepts is the be-all and end-all of philosophy, even the analytical part of philosophy. But perhaps we can move from concepts 2 to concepts 3 , i.e., shared (psychological) concepts.*"[39] pp 16-17

[8] "*My favored kind of epistemological naturalism holds that warrant, or justification, arises from, or supervenes on, psychological processes that are causally responsible for belief (Goldman 1986, 1994).*" [39] p.19

[9] "*A first reply is that, in my view, there is no incompatibility between naturalism and a priori warrant.*"[39] p.19

[10] "*Having attempted to establish premises (1)-(4), it is now time to draw conclusions from the incompatibility of naturalized metaphysics with a commitment to robust realism about the entities in metaphysical theories.*" [4] p 292

3.2 The issue of the conceptual scheme indetermination

Another kind of argument against classical ontological realism, initially proposed by Putnam [59] in support of his *internal realism* and lately generalized by Chalmers [3], suggests that even if there were strong shared concepts as understood in Goldman's CSMM, the very possibility that an intelligent organism could posses a different conceptual structure challenges the idea that our own fits with the structure of reality.

As an example, while any one would count two objects on the table (mug1 and mug2), we could perfectly imagine that a martian with a different conceptual scheme, would consider mereological sums of distinct objects as genuine entities and thus count three objects (mug1, mug2 and mug1+mug2). In a similar fashion, this martian would consider a *table-cat* as genuine entity he observes when Fritz is one the table.

4 Is Our Cognitive Scheme Arbitrary?

Both arguments rely on the same structure which could be summed up this way:

uniqueness assumption if there are mind-independent categories as PO suggests, there must be only one correct ontology
ontological pluralism There is or can be different cognitive ontologies (CO)
CSMM PO depends on, fit or are supported by CO or, at least, by some of their by-products (i.e. intuitions)
ontological antirealism thus ontological realism is false

As a *sine qua none* condition for the PO realism, we do not have the choice but to maintain the *uniqueness assumption*. Likewise, we take for granted that our actual cognitive scheme produces intuitions which support first order metaphysical claims about the properties of the most basic components of the world – a.k.a. CSMM. To avoid the *ontological antirealism* conclusion of this argument, we shall thus focus on its *ontological pluralism* premise. As we saw, the *ontological-pluralism* component of the argument comes with two variants: an actual one – based on the contradiction of intuitions – and a potential one – the conceivability of an *alien conceptual structure*. We shall first deal with the former before we come to the potential variant of the latter.

4.1 Robust VS weak primitive cognitive components of mental representations

Allen's conflation of Naturalized Metaphysics with Goldman's CSMM misses the crucial point that meta-metaphysics differs from first order metaphysics. Yet, CSMM is not a first order science-based metaphysics but a second order scientific investigation on the intuitions that provide first order metaphysical claims and their cognitive bases. Thus, CSMM does not contradict the *a priori* metaphysics but explains it.

This said, the issue whether intuitions and their cognitive origins are robust enough remains. However both classical and contemporary research has underlined a great number of primitive representational invariants from colours perception [60] to causal induction [61, 62] or individuation criterion [51]. Though the question remains an empirical one to be decided by science rather than philosophy, we would like to dispel a fallacy. It has been argued that categories change from one culture to another. However, such an account confuses the content level categories – i.e. categories as the cognitive correlate of natural kinds such as "*cats*" or "*tables*" see [63] – and what Guarino [22] called *meta-level categories* – i.e. different types of being. In other words, this account conflates epistemological and ontological issues. Different people may well *categorize* (in the first sense) differently, but what is at sake in cognitive ontology and its relation with ontological realism is whether the underling cognitive components are the same.

As an example, Sheppard [64, 20] has supported the idea that the generalisation laws which underline categorisation are universal, thus robust enough to maintain the realist view that some of our primitive knowledge about solids or colours – a.k.a. our cognitive ontology – reflects the physical properties of the world. More recently, the Theory-based Bayesian models [65, 66] have suggested that concept learning relies on inferences, success of which depends on the correct grasping of the hidden structure of the data set – i.e. inferences about the relationship that second order entities (putative natural kinds) entertain. In other words, being able to learn the meaning of concepts requires to possessing some prior knowledge about the existence of entities – i.e. natural kinds – types of which differ from the ones of stimuli. From the point of view of such primitive components, our actual cognitive schemes appear more stable than initially thought.

4.2 Cognitive Ontologies beyond our actual conceptual scheme

So far, we restricted ourselves to the issue about the existence of a unique human CO and its relation with PO. However, the challenge raised by Chalmers [3] remains. One way to overcome this issue consists in wondering whether some intelligent agent, an alien, could make sense of the world without distinguishing, say, perdurant (events) from endurant (individuals) beings, or genuine objects from any arbitrary mereological sum.

Here is where Information System Ontologies (ISO) occurs. In this final section, we would like to support the idea that 1) reflexions around ISO might rule out the very possibility of such an intelligent agent and thus 2) provide support for ontological realism.

Critical realism in IS It should first be acknowledged that the issue of the realism of knowledge representation in IS is not a new one. As an example, arguments for *critical realism* as the underlying philosophy of IS have been lately advocated as a way to overcome practical inconsistencies [67, 68]. Here is how the argument is conceived.

As general views on knowledge and scientific practices, *empiricism* – i.e. a regularity-based view of science – and *conventionalism* – i.e. the cultural dependency of theoretical objects – impacts the way IS are conceived and realized. While mere statistical inferences supported by *empiricism* may fail to explain regularities, arbitrary reifications supported by the relativist part of *conventionalism* may also fail to explain the success of some reifications rather than others. This argument, similar to the classical *no-miracle argument*[11], drives Mingers to support that the stratification of IS ontological domains should be conceived as the way the *structure of reality* dictates the conditions of possibility of knowledge.

[11] "*The argument is that neither empiricism nor idealism can successfully explain these occurrences and that they necessitate some form of realist ontology.*" [67] p92

> In contrast to this [Kant's transcendental idealism] critical realism asserts that the conditions for knowledge do not arise in our minds but in the structure of reality, and that such knowledge will not be universal and ahistorical. [67] p92

Information and belief: a functionalist account Though philosophically relevant, this attempt to *real-izing* information systems [67] remains limited, for 1) it takes PO implicit realism as a premise rather than a conclusion and 2) does not rule out the possibility that another stratification of IS ontological domain might solve representational issues as well. We suggest that machine-based information systems might solve this issue.

Here, we are committed in the idea formulated a decade ago by cognitive informatics [69, 70] that every single cognitive issue posses a computational counterpart. From a purely functional point of view, every human intentional act – perception, communication or recollection – can be conceived as information retrieval tasks which make use of structural properties of information. From a great variety of retinal patterns, I will use criteria such as continuity to perceive Fritz crossing my desktop rather than a succession of "*here and now catness*" as in the classical Quinean argument for ontological plurality [37]. Likewise, with "*Fritz the cat is crossing my desktop*", the grammatical structure of this utterance indicate the kind of beings induced in a certain state of affairs.

The same holds for an inference engine. However, an expert system – i.e. an inference engine with a data base [34] – lives in a world far different from our own: *a sea of information* [2] some of which differs crucially from the ecological entities homo sapiens and other animals are confronted with – some of the most striking examples can be found in biomedical information systems such as SNOMED CT [71] or the Open Biological Ontologies [72] domains of which are populated by genes, organs, illnesses and their respective properties and families. Yet, the same fitness-based arguments hold, though they are formulated in term of:

computational cost a well organized database speeds up information processing [34] the same way early pattern recognition enhance neural encoding

inferential success inferences based on a well founded ontology are more reliable than merely first order, descriptive systems [34]

re-usability enhance knowledge sharing across different systems so as to infer new facts about the given domain – a.k.a. interoperability [73]

We should stress that this last argument should not be conceived as the adoption of a common vocabulary[12]. We may put two reasons forward. First off all, adopting a certain ontology is not a referential issue. As we said earlier, to adopt a certain ontology is not to fix the meaning of a particular entity – say *Fritz* or *cats* – but to consider that a certain hierarchical structure of types of being – together with their respective properties such as *is-part-of*, *contains-process* or *has-specific-dependent-at-some-time* – is a good way to represent knowledge[13]. This is even more striking when we consider *upper level ontologies* categories of which – see figures 3 and 4 – are supposed to represent adequately any fact, no matter what the domain is – see section 1.3.

Secondly, the probability that any arbitrary "*common vocabulary*" might solve computational issues the way BFO increased the inferential power of biomedical IS such as the Foundational Model of Anatomy (FMA [74]) or the Gene Ontology (GO [75, 76]) seems very remote [77]. We may borrow Spear's expression for this parsimonious conclusion: computers – understood as inference engines – are "*dumb beasts*". What makes them smart is the way data is encoded, the way data – "*raw pieces of abstract items or things*" – becomes information – "*data that has been assigned attributes along with limited logical relationship between data*" [78] – in the way the *New Information Theory* [70] conceives it.

To which extent does it solve the issue of ontological realism? But what about the less parsimonious conclusion? The account about ISO realism we sketched above may remind one of the classical naturalisation of truth as useful belief together with the issue this framework raised in the 80' – see section 2.2. We intend to suggest that the situation differs for at least three reasons.

First of all, as an ontological account on representations rather than an epistemological one, the naturalisation of ontology we proposed does not directly concern particular beliefs but their structural constraints – for instance, the fact that I can conceive a golden mountain but cannot imagine a round square rather than the existence of such a mountain. This ontological turn has practical consequences on the historical anti-realist arguments. As an example, Putnam's argument for the *inscrutability of the reference* by permutation – the fact that "*The cat is on the doormat*" might be true in a world in which "*cat*" means cherry and "*doormat*" means cherry tree [79] chap 2 – becomes harmless in such a context, for what is at stake concerns the existence of a common type of being able to entertain a certain kind of relation – instantiated here by *being-on*.

Secondly, while a biological entity cannot change its cognitive structure, the same data base can be organized by means of many different ISO. The crucial practical aftermath of this is that the respective fitness – computational cost, inferential success and re-usability – of different ontologies could thus be compared the way it has been done for Biomedical IS [77]. In other words, the adaptation of the most primitive cognitive constraints on the representations of a generic intelligent agent may become an empirical investigation rather than an armchair or intuitive *third person conceptual investigation* as advocated by Goldman – see section 2.2.

The reader may retort that the very notion of *fitness* remains dependent on the human cognitive scheme, given that 1) human agents enter data in the database and thus transmit or, at least, expect ISO to be consistent with their own CO. However, the idea that IS structures capture some of the very grounded primitive components of the human representational system does not mean that ISO are expected to fit entirely with CO. While categories from some upper ontologies such as DOLCE [16] were built so as to fit common sense as expressed in natural languages, the *zero-dimensional temporal region* of the BFO [30] – temporal region without extent – does not seem intuitive *prima facie*.

Finally, the ability to produce ontological-based predictions, inferences of which would not have been anticipated by any human agent, rules out an important argument for CO dispensability. As an example, the classical debate around naturalized epistemology has suggested that categories of CO may be conceived as a way to make the physical world predictable by by-passing the computational limitations of the human brain – see [56]. However, given the computational power currently available by expert systems together with ISO impacts on their capacities, the possibility that an intelligent agent

[12] "*The ontological problem of information repository construction and management is not, however, simply the problem of agreeing on the use of a common vocabulary.*" [2] p.7

[13] "*Rather, it is the problem of adopting a (sometimes very general) set of basic categories of objects, of determining what kinds of entities fall within each of these categories of objects, and of determining what relationships hold within and amongst the different categories in the ontology.*" [2] p.7

could make sense of the world without discriminating *kinds of beings* as primitive as *Sortals* seems remote. To put it in other words, ISO efficiency on the tasks of machine-based IS suggests some kind of necessity behind our own cognitive scheme (CO).

Conclusion

Confronted with the incompatibility of *Cognitive Science based Meta-Metaphysics* [5, 39] and ontological realism advocated by Chalmers [3] and Allen [4], we choose to question their assumption about the indetermination of our *Cognitive Ontology*. From this point of view, it remains possible to support both the idea that first order metaphysical assumptions reflect some primitive, embodied, representational constraint with a certain variety of ontological realism. By means of a *no-miracle argument* at the level of categories rather than belief toward particulars, *upper level ontologies* applied to information systems provide evidence about the existence of generic and putatively universal cognitive constraints for both humans and machines representations of reality, which supports a realist position about categories.

Though the attempt to reconcile realism and the representational dimension of knowledge in cognitive sciences [20, 64] and information systems [15] is not a new one, the account we proposed differs in two ways. While cognitive science-based realism rarely distinguishes the ontological issue from the epistemological one, we advocated that it is possible to be realist about the formers without facing the difficulties raised by the naturalization of the latter. Secondly, while supporters of information systems realism take the philosophically implicit realism as a foundational premise [80, 15, 68], the present account advocates that considering machine-based information systems as generic cognitive agents might support this very debated premise.

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