Contexts: A Grounding Perspective

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Abstract. Contexts remain nebulous concepts notwithstanding their relevance to practical ontological modeling. In this paper we propose by leveraging a meta-ontological notion of grounding that a context for a fact be conceptualized as a fact that partly grounds the fact under consideration. This work would constitute a further step from Cory Casanave's recent view that a context acts as a mediator between a set of propositions (or rules) and the things that are contextualized.

Keywords. context, grounding, fact, proposition, state of affairs

1. Introduction

Ontologies are usually constructed to enhance the interoperability and integration of data that are dispersed in different information systems, including databases. They are thus designed to provide a general representation of reality that holds independently of specific circumstances. It is an ontological finding, for instance, that a student can be classified as a role regardless of which particular student or school we are discussing. In contrast, our knowledge of the world is mostly context-dependent; and ignorance of the contextuality of information would yield undesirable consequences. When it is ordered to go right at the fork to move away, for example, a robot may fail to reach her destination when it collides with an obstacle that is located in the right road and that she has never encountered in choosing the same path. The robot should be then reprogrammed to proceed in an appropriate direction depending on ever-changing situations.

A full ontological exploitation of knowledge therefore requires that its context-sensitivity be taken with the utmost seriousness. Indeed, classifications of contexts have been discussed comparatively intensively for the last two decades. For instance, Hayes [1] identifies four kinds of contexts (physical, linguistic, conceptual, and deductive) from a linguistic point of view. For another example, Borgo et al. [2] introduce three types of contexts (global, local, and internal) to classify an agent's knowledge in the manufacturing domain. Contexts are nonetheless notoriously difficult to analyze from an ontological perspective, in spite of a growing demand for their formal specification.

This short paper aims to take the initial step towards a deeper understanding of the ontological nature of contexts. Our methodology is to deploy a so-called 'meta-ontological' notion of grounding (which we will delineate below). In ontology engineering, there is an increasing practical interest in meta-ontology [3] as a second-order inquiry into ontologies. Among meta-ontological concepts is a truthmaker [4,5]: something that 'makes true' (i.e., bears the 'truthmaking relation' towards) a proposition. For instance, Japan can be a truthmaker for the proposition that Japan exists. The idea of

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truthmaker or truthmaking has been employed for the last decade to clarify complex ontological categories and relations. Examples include the formalization of states as truthmakers for propositions [6] and the conceptualization of properties, relations, and events in terms of 'truthmaking patterns' [7,8]. As a sibling notion of truthmaking, grounding has been only recently used, e.g., to analyze the role concept in upper ontologies [9, 10]. Our grounding approach to contexts would therefore contribute to a new ontological approach to contexts and to heightened awareness of grounding in foundational ontology research.

The paper is organized as follows. Section 2 presents a general idea of contexts and related work, or especially Casanave's [11] 'mediator view' of contexts. Section 3 explains a meta-ontological concept of grounding. Section 4 sketches out a grounding analysis of contexts. Section 5 concludes the paper with some remarks on future work.

2. Contexts

2.1. General Ideas

Contexts are doubtlessly elusive concepts, but Baclawski et al. [12] articulate their basic idea: "In general, a context is commonly understood to be the circumstances that form the setting for an event, statement, process, or idea, and in terms of which the event, statement, process, or idea can be understood and assessed. Thus for utterance statements we often talk of the linguistic context of what is being expressed. In addition, there may be a physical context, circumstance or state of affairs in the real world that provides context for uttered statements. Some examples of synonyms or alternate terms that have the flavor of context include circumstances, conditions, factors, perspective, scope, state of affairs, situation, background, scene, setting, and frame(s) of reference."

Based on this general idea, we can identify at least two key features of contexts. First, it is a meta-level entity: a context is always a context *for* something. To take an example, the meaning of a sentence "I am hungry" varies from context to context, and in this case we are speaking of a (linguistic) context *for* the uttered sentence. Second and closely relatedly, a context consists in changing our interpretation of something else (for which the context holds). When Ann sincerely utters "I am hungry," we are justified in thinking that Ann is hungry; but we are mistaken in believing so when Bob (but not Ann) sincerely utters the same sentence.

2.2. Related Work: Casanave's Mediator View

There are presently few ontological investigations into contexts, notwithstanding several classifications of (linguistic and/or cognitive) contexts [1,2] and rich philosophical discussion on (linguistic) contexts [13]. According to Baclawski et al. [12], Casanave [11] can be construed as espousing a 'mediator view' of contexts based on the intuition that a context is "anything that impacts the interpretation or truth value of something else." For him, a context acts as a mediator between a set of propositions (or rules) and the things, where in his terminology, the words therein 'proposition' and 'thing' mean the 'interpretations/truth values' and the 'something else', respectively. In more detail, a proposition *holds within* a context, which in turn *contextualizes* the things; and a true

context *implies* that the propositions that hold within the context hold for all things that the context contextualizes (see Figure 1).
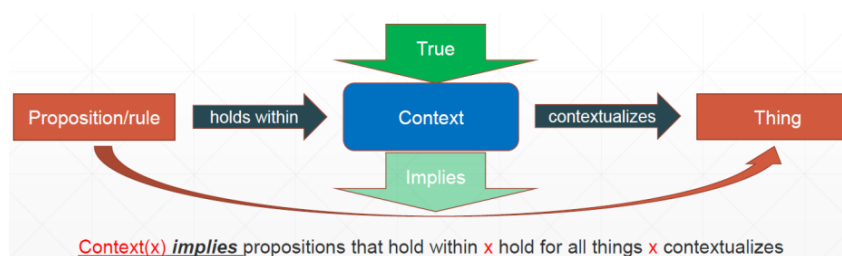

Figure 1. Casanave's [11, Slide 15] Mediator View of Context

Casanave's mediator (albeit preliminary) account of context is well worth noting. For one thing, it aims at a general notion of context: "This pattern works for many contextual dimensions such as time, location and provenance" [12]. For another, it attempts to capture the core idea of context (namely, a meta-level entity that changes our construal of the world) in terms of the ontological notion of proposition. Contrariwise, there is some room for improvement in the concepts in his schema, or specifically the relations used: e.g., the holds-within relation between propositions and a context.

3. Grounding

3.1. Fact-grounding

To move beyond Casanave [11], we leverage a meta-ontological tool of grounding [14-16] or especially the most orthodox version of grounding as a primitive relation between facts [17,18]. For instance, the fact (say F_1) that a table exists is grounded in the fact (say F_2) that some subatomic particles are arranged table-wise; and informally speaking, F_1 holds 'in virtue of' F_2. The theory of fact-grounding is usually coupled with the claim that the grounding relation at least entails explanation (see [16] for controversy over the relationship between grounding and explanation). In the table example, F_2 grounds, and *ipso facto* explains F_1. Grounding is also so analogous with causation that one may sometimes call grounding 'ontological causation' [19].

Fact-grounding presupposes an ontology of facts. To keep things manageable, we leave aside the problematic character of facts (see e.g., [20]) and simply say that the term 'fact' is typically interpreted either as a true proposition or as a state of affairs. On the one hand, a proposition is standardly taken to play three major roles:

- The semantic content of a (declarative) sentence. E.g., two sentences "Snow is white" and "La neige est blanche" express the same proposition that snow is white.
- The object of various linguistic and cognitive attitudes ('propositional attitudes') including belief, assertion, and denial. E.g., when she sincerely utters

"Snow is white," Mary bears the believing attitude towards the proposition that snow is white.

- The truthbearer: the bearer of truth-values (truth and falsehood). E.g., the proposition that snow is white is true.

On the other hand, a state of affairs is a concrete, non-linguistic portion of reality, but with a 'propositional structure': e.g., a state of affairs of snow being white [21]. A fact can be therefore described as something that 'holds' in reality in virtue of its propositional structure, irrespective of whether it is a true proposition or a state of affairs.

3.2. Full and Partial Grounding

We can distinguish two kinds of grounding relations: full and partial grounding [18]. A plurality of facts $F_1, F_2, \ldots$ *fully ground* a fact G (symbolization: $F_1, F_2, \ldots \Rightarrow G$) when $F_1, F_2, \ldots$ ground G collectively and completely; and a fact F *partly grounds* a fact G (symbolization: $F \rightarrow G$) when F grounds G singly and partially. Partial grounding can be naturally defined in terms of full grounding: $F \rightarrow G$ if and only if there exist $F_1, F_2, \ldots$ such that $F, F_1, F_2, \ldots \Rightarrow G$. To illustrate them, let H and I be the fact that Japan is an eastern Asian country and the fact that Japan has a population of nearly 130 million, respectively; and let J the fact that Japan is an eastern Asian country with a population of nearly 130 million. Then, the following claims hold: $H \rightarrow J$, $I \rightarrow J$, and $H, I \Rightarrow J$.

We can also speak of some formal properties of grounding (whether full or partial) [18]. (i) Irreflexivity: no fact grounds itself. (ii) Transitivity: if a fact F_1 grounds a fact F_2, which in turn grounds a fact F_3, then F_1 grounds F_3. From (i) and (ii) follows straightforwardly the asymmetricity of grounding: if a fact F_1 grounds a fact F_2, then it is not the case that F_2 grounds F_1. To simplify the matter, we set aside a highly debatable topic of whether grounding is, in some sense, 'well-founded': whether it has no infinite descending chains or not (see e.g., [22] for details).

4. Towards a Grounding Analysis of Contexts

Going back to contexts, we suggest that contexts be specified in terms of grounding. The underlying idea is that closer examination of the meta-level concept of context would necessitate the usage of some meta-ontological tool such as grounding. In particular, the idea of partial grounding is vital for considering contexts. Baclawski et al. [12] contend: "any reasoning about context is (…) about the methods for finding some implicit information that should be added to the interpretation of the subject." Suppose that F_1, $F_2 \Rightarrow G$. Then, F_1 (resp. F_2) would seem to deserve a context for G especially when we tend to believe *falsely* that $F_2 \Rightarrow G$ (resp. $F_1 \Rightarrow G$) while neglecting an implicit fact F_1 (resp. F_2). It is thus reasonable to characterize contexts in terms of partial grounding: a context for a fact G is a fact that partly grounds G.

Let us illustrate this thesis with the weight/mass example borrowed from Casanave [11]. To do so, we will use the following list of facts:

- F_1: Weight can be calculated by multiplying mass by gravitational acceleration.
- F_2: Bob's mass is 100 kilograms.
- F_3: The gravitational acceleration on the earth is 9.8 m/s^2.
- F_4: The gravitational acceleration on the moon is 1.62 m/s^2.

- F_5: Bob is on the surface of the earth.
- F_6: Bob is on the surface of the moon.
- G_1: Bob's weight is 980 N.
- G_2: Bob's weight is 162 N.

Casanave asserts that the surface of the earth provides a 'location context' for the rule about the convertibility of mass into weight. This statement can be interpreted as saying that F_5 is a context for G_1 and hence as the partial grounding $F_5 \rightarrow G_1$, which follows from the full grounding $F_1, F_2, F_3, F_5 \Rightarrow G_1$. The same argument over location context would apply to the surface of the moon: F_6 is a context for G_2 in the sense that the partial grounding $F_6 \rightarrow G_2$ holds, which follows from the full grounding $F_1, F_2, F_4, F_6 \Rightarrow G_2$.

Grounding would enable us to discuss other kinds of contexts than location ones. One may attribute G_1, for instance, to the historical context in which weight became fundamentally separate from mass in modern physics. Let F_0 be the fact that modern physics brought about a sharp distinction between weight and mass. To say that F_0 is a (historical) context for G_1 amounts to the partial grounding $F_0 \rightarrow G_1$, which follows by the transitivity of partial grounding from $F_0 \rightarrow F_1$ and $F_1 \rightarrow G_1$. Quite importantly, the same line of reasoning would not mesh with the truthmaking relation because it fails to preserve the property of chaining [18]. Although meta-ontological, truthmaking may be too restrictive to serve as a conceptual tool for analyzing contexts.

Let us finally compare our grounding perspective on contexts with Casanave's [11] mediator view of them. First of all, our schema for contexts is simpler than his because the former is based on one kind of category (fact) and relation (grounding), whereas the latter on multiple categories (propositions and things) and relations (the holds-within relation, contextualization, and implication). Seen from a different standpoint, his model could possibly reduce to ours when our notion of fact is interpreted as a (true) proposition. One may worry that, unlike Casanave's, our approach would offer no room for talk of objects as contexts: e.g., "Oxygen is a physical context for burning." In ontological parlance, however, this claim should be construed more meticulously using fact-grounding: the fact that an object burns is grounded in the fact that oxygen *is present* around a flammable object. Additionally, Casanave states that a context can be false (e.g., "We are not on the surface of the moon") and says: "If a context is false, propositions do not hold for what the context contextualizes." Instead of allowing contexts to have truth-values, we think that his alleged falsity of contexts would be explicable in terms of the failed (partial) grounding relation. Let F^*_5 be the fact that Bob is not on the surface of the earth. To say that F^*_5 is a 'false context' for G_1 would be equivalent to the failed partial grounding of G_1 in F^*_5: i.e., it is not the case that $F^*_5 \rightarrow G_1$.

5. Conclusion

To summarize, we proposed a novel ontological approach to contexts by exploiting a meta-ontological notion of grounding, which would be preferable to the truthmaking relation for our present purpose. The main finding is that a context for a fact F can be characterized as a fact that partly grounds F. This work would constitute a further step from Casanave's relevant mediator view of contexts.

In the future we will deepen our grounding-based conceptualization and formalization of contexts, e.g., by deploying existing works on the logic of grounding [23-25]. This will contribute to a computational approach to contexts. It would be also a

noteworthy line of research to apply this work to the development of a previous grounding analysis of the role concept [9,10] since content-dependency is one of the essential features of role [26].

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