Ontological Complexity and Human Culture

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ABSTRACT
Ontologies are being used by information scientists in order to facilitate the sharing of meaningful information. However, computational ontologies are problematic in that they often decontextualize information. The semantic content of information is dependent upon the context in which it exists and the experience through which it emerges. For true semantic interoperability to occur among diverse information systems, within or across domains, information must remain contextualized. In order to bring more context to computational ontologies, we introduce culture as an essential concept for information science. Culture helps to focus our attention on and make meaning of relevant extrapersonal structures and their qualities and dimensions that comprise the context and background of the world. In our approach, culture is integral to the study of semantics and, consequently, the study of ontologies and information technologies. The meaning we make of entities and phenomena in the world is always shaped by our cultural experience. If we understand culture as the emergent interplay of intrapersonal cognitive structures and extrapersonal structures of the world, then the notion of cognitive and cultural schemas becomes essential to understanding ontology and the ways in which we might achieve authentic semantic interoperability among diverse information systems. We explore the nature of ontologies and reconceptualize them as cultural schemas. Our proposal is an alternative to the historical path from philosophical ontology to computational ontologies as one that adheres primarily to the notion of ontology as a categorization and classification system. The obvious implication for ontology as categorization is that there is a single objective world that exists and that it can be described as entirely separate from the person observing it. We draw upon Heidegger's examination of ontology to ground ontology in a phenomenological perspective, enabling it to remain flexible and adaptable and to accommodate context.

Keywords
Ontology, category, phenomenology, hermeneutic, culture, schemas

INTRODUCTION

The explosion of the infosphere has lead to a proliferation of metadata and formal ontology artifacts for information systems. Information scientists are creating ontologies and metadata in order to facilitate the sharing of meaningful information rather than similarly structured information. Formal ontologies are a complex form of metadata that specify the underlying concepts and their relationships that comprise the information *of* and *for* an information system [1]. The most common understanding of ontology in computer and information sciences is Gruber's "specification of a conceptualization" [2, 3]. However, formal ontologies are problematic in that they simultaneously crystallize and decontextualize information, which in order to be meaningful must be adaptive in context. In trying to construct a correct taxonomical system, formal ontologies are focused on syntactic precision rather than meaningful exchange of information. Smith [4] describes accurately the motivation and practice of ontology creation:

> "It becomes a theory of the ontological content of certain representations…. The elicited principles may or may not be true, but this, to the practitioner...is of no concern, since the significance of these principles lies elsewhere—for instance in yielding a correct account of the taxonomical system used by speakers of a given language or by scientists working in a given discipline."

It is not fair to claim that syntax is irrelevant, but the meaning we make of information is dependent upon more than its syntactic structure. The semantic content of information is dependent upon the context in which it exists and the experience through which it emerges [5]. For true semantic interoperability to occur among diverse information systems, within or across domains, information must remain contextualized.

Heidegger's [6] phenomenological examination of ontology, which includes the notion of being-in-the-world, is one in which each of us is immersed in and never separate from an experiential context. This context is the ever-present background and historical experience that shapes our semantic and ontological commitments to the world—helps us make meaning of what we perceive to exist. Moreover, we are always being-in-becoming, experiencing the world as emergent--dynamic,

contextualized and with a personal historical perspective. It is this ontological notion of being-in-becoming that allows us to introduce the notion of culture to the study of ontology in information science.

Even though Heidegger shifted the grounding of ontology in philosophy from the categorical to the phenomenological, information scientists still adhere to the notion of classification and categorization as the essence of ontology. While this may be necessary to deal with the limitations of computational systems that function primarily as symbol processors, it also constrains our ability to address the conceptual and semantic dimensions of ontology. Integral to understanding ontology, to understanding being, is the notion of background and culture—what Heidegger refers to as being-in-the-world. What exists does not exist independently of the Being that is experiencing it, nor does it exist independently of the contextual background in which it is being experienced. The clear line between subject and object, or between object and object, that exists in an Aristotelian categorical notion of ontology becomes irreversibly blurred in a Heideggerian phenomenological notion of ontology. If we are to understand being, and hence ontology as the theory of being, we must not separate ourselves from the world which is integral to our experience. If we are to understand information we must not objectify it as an entity that exists independently of ourselves. We must strive to retain the context that provides the semantic content necessary for sharing information and knowledge.

The notion of culture as described by cultural anthropologists is Heidegger's being-in-becoming—an emerging experience of the individual in a situational context. Cultural anthropologists describe culture as a phenomenon that emerges through the interplay of intrapersonal cognitive structures and extrapersonal structures in the world [7, 8]. Culture is a phenomenon integral to our experience and one that shapes our ontological commitments to the world around us. Our experience is always a cultural experience. Our individual cognitive experience of the world is dependent in large part upon our cultural experience. What we presume to exist and the meaning that we make of the world is dependent upon our cultural schemas and experiences. Culture helps to focus our attention on and make meaning of relevant extrapersonal structures and their qualities and dimensions that comprise the context and background of the world.

Its role in the creation of meaning makes culture integral to the study of semantics and, consequently, the study of ontologies and information technologies. The meaning we make of entities and phenomena in the world is always shaped by our cultural experience. And if we understand culture as the emergent interplay of intrapersonal cognitive structures and extrapersonal structures of the world, then the notion of cognitive and cultural schemas becomes essential to understanding ontologies and the ways in which we might achieve authentic semantic interoperability among diverse information systems.

In this paper we introduce culture as an essential concept for information science. We explore the nature of ontologies and reconceptualize them as cultural schemas. We draw upon Heidegger's examination of ontology to ground ontology in a phenomenological perspective, enabling it to remain flexible and adaptable and to accommodate context.

ONTOLOGY AS CATEGORY

Ontology is a philosophia prima concerned with the theory of being, i.e., what exists. In his Metaphysics, Aristotle describes Ontology as regarding "all the species of being qua being and the attributes which belong to it qua being" [9]. A "true" ontology would be one--and there would be only one--in which all things of existence and their relationships with one another were described in a single coherent and comprehensive treatise [4]. Aristotle determined this to mean that everything could be described through a system of hierarchical categories. The historical path from philosophical ontology to computational ontologies is one that adheres primarily to the notion of ontology as a categorization and classification system. The obvious implication for ontology as categorization is that there is a single objective world that exists and that it can be described as entirely separate from the person observing it.

Interestingly while logicians and researchers, especially from Western cultural traditions, have adopted a rationalistic worldview [5] such that there exists a single objective world and that we can separate ourselves as subjects observing it, they have also recognized that different domains often have a different understanding of the same concept. This idea of differing ontological conceptualizations was described by Quine [10], who set forth the task of the ontologist as discerning what types of entities scientists are committed to in their theories, which are discipline-specific. This specificity means that relations among objects belonging to different domains are not necessarily compatible, resulting in multiple ontologies among the domains [4]. Ontology in the traditional philosophical sense is then replaced by domain-specific conceptualizations. This shift from ontology (singular, encompassing everything) to ontologies (plural, restricted to a particular domain), from an external to internal metaphysics, identified by Quine for the natural sciences, has found its way into the social science disciplines. Psychologists and anthropologists have attempted to elicit the ontological commitments of individuals and cultures in much the same way as philosophers of the natural sciences [4, 11, 12]. However, the idea that there is a single objective world separate from the persons observing it, and that humans can discern it through the study of categories, still permeates the ontological commitments of natural and social science disciplines. The multiplicity of ontologies recognizes

the fact that there are varied human understandings of this objective world, not that those varied understandings constitute a multiplicity of non-objective worlds.

Though dominant, "specification of a conceptualization" is not the only definition of ontology that exists among contemporary researchers. People interpret ontology to be philosophical, semantic, conceptual, formal, informal, representation, logical-theoretic, property-driven, purpose-driven, vocabulary, specification, and/or multi-leveled. Guarino [13] identified seven distinct ways in which people interpret the term, "ontology:" (1) as a philosophical discipline; (2) an informal conceptual system; (3) a formal semantic account; (4) a specification of a "conceptualization;" (5) a representation of a conceptual system via a logical theory, (5.1) characterized by specific formal properties, (5.2) characterized only by its specific purpose; (6) the vocabulary used by a logical theory; and (7) a meta-level specification of a logical theory. Interpretations 4-7 are the dominant interpretations for information and computer sciences. These interpretations have impact on the development, construction and use of ontologies in the wild (*pace* Hutchins).

Difficulties in practice highlight conceptual problems regarding ontologies such that for many ontology has come to mean one of two things: a representation vocabulary, or a body of knowledge describing some domain [3]. Ontology is the conceptualizations underlying the representational vocabulary, not the vocabulary itself; it is the conceptualizations of relationships that constitute a body of knowledge, not the description itself. Translating from one language to another, according to this view, does not alter the ontology conceptually--a transistor is a transistor is a transistor no matter whether the vocabulary representing it is in English or Farsi or Cantonese. As a body of knowledge describing a domain, ontology attempts to specify the relationships of the concepts--a transistor is a component of operational amplifier, or that an operational amplifier is a type of electronic device. Casting ontology as categorical constrains its applicability to new information and new contexts, making the refinement or merging of these complex artifacts nearly impossible as any changes tend to break the them.

One difficulty with ontology-as-category is the lack of consensus as to what those categories should be or how they should be organized. Even with as fundamental a concept as *class*, ontologists lack consensus [14]:

> The most basic concepts in a domain should correspond to classes that are the roots of various taxonomic trees. [15] Concepts are terminological descriptions of classes of individuals. [16] Concepts represent classes of objects. [17] Just as in the object-oriented paradigm, there are two fundamental types of concepts in KM: *instances* (individuals) and *classes* (types of individuals). [18] … Classes represent concepts, which are taken in a broad sense. [17] A class is a set of entities. Each of the entities in a class is said to be an instance of the class. An entity can be an instance of multiple classes, which are called its types. A class can be an instance of a class. [19] The class *rdfs:Class* defines the class of all classes. [17] A class has an intensional meaning (the underlying concept) which is related but not equal to its class extension. [20] … Instances are used to represent elements or individuals in an ontology. (…) Individuals represent instances of classes. (…) Individuals represent instances of concepts. [17] Individuals are assertional, and are considered instances of concepts. [16]

Kuśnierczyk observes, "The issue is not merely one of incoherent nomenclature: it is not clear whether a class of all classes, and those classes themselves, are elements of the represented domain, elements of a formal representation of the domain, or, perhaps, elements of a representation of a mental imagination of the domain." The way in which ontological engineers use *class* and *concept* interchangeably reveals the lack of clarity among those whose work is to produce precise descriptions and definitions for systems interoperability. With the lack of consensus as to what constitutes a *class* or a *concept*, which are supposedly fundamental to ontologies, it is not surprising that ontology modification and integration is a problematic endeavor [21].

Different ontologists will categorize differently, use different descriptors to specify their conceptualizations of the things of the world. Yet despite these difficulties ontology as the study of categories persists. All categorization schemes impose a rigid or semi-rigid structure onto the entities or phenomena being described. In essence, they attempt to get back to the source of Aristotle's ontological pursuit and create categories that enable the classification and categorization of any thing that exists in the world. The underlying assumption to all of these hierarchies is that they objectively describe an objective world. The plethora of structures and vocabulary within and across domains indicates, however, that the ontologies are non-objective descriptions of non-objective worlds.

While information systems are generally good at connecting incompatible systems by using or translating protocols and formats, they often fail when it comes to interpreting the meaning of specific information [22]. If the semantic content of some information does not comply with the formal ontological structure of the information system, it is not usable or interpretable by the system. The problem is one of meaning, and it is compounded by the fact that any or all of the meanings of a particular entity or phenomenon may be used by different people at different times. Smith [4] calls this the Tower of Babel Problem: different groups, including data- and knowledge-base system designers, have their own terms and concepts

for understanding and building representative frameworks. Identical labels may have entirely different meanings; or the same meaning may have different labels. Information systems using different ontological classifications aren't able to communicate easily without additional layers of metadata that allow them to map one ontology to another.

ONTOLOGY AS HERMENEUTIC

Even though the notion of ontology has continued to evolve in philosophy, information scientists still adhere to the notion of classification and categorization as the essence of ontology. Ontology from an existentialist and phenomenological perspective is not the study of categories of being but rather the study of experience of being:

> Basically, all ontology, no matter how rich and firmly compacted a system of categories it has at its disposal, remains blind and perverted from its ownmost aim, if it has not first adequately clarified the meaning of Being, and conceived this clarification as its fundamental task. (Heidegger, *Being and Time*, p. 31, H. 11)

The 'problem' of ontology arises from the tension between what Heidegger describes as the ontological and the ontic—between the conceptualizations we develop through experience and the instantiations of those conceptualizations that comprise entities and phenomena in the world. What is the relationship between the rich ontological understanding and conceptualizations we have based upon our experiential being and the seemingly objective ontic instantiations of what we encounter in our experience? The question lies at the heart of metaphysics and our philosophies of science, and is perhaps most critical for information science. We need to see the world as objective and distinct from ourselves, to believe that we are not solipsistic 'brains in vats' merely imagining that a world exists rather than one existing actually. We reinforce this need by objectifying nature, by imposing order on all data, to make all types of entities subject to processing [23]. We engage in this type of activity as scientists because our traditional ontological stance derives from the question, "What *is* it?" Heidegger asks a more difficult and vexing question: What does it mean *to be*? And at the center of this inquiry dwells man and his *being-in-the-world*.

We humans are unable to escape our experiential contexts. The essential nature of man's being is to understand, to make meaning of our experiences, of our world. Indeed, we cannot help but make meaning of our experiences, whether we are able to articulate them through language or not. We make this meaning individually and collectively. We share our experiences of *being-in-the-world* with others, and as such, Heidegger says, we are always *being-in-the-world-with-others*. When we share with others we do so from a personal historical perspective, from the sum total of our experiences and the understanding we have created about them. Our experiences are always contextualized and the meaning we share with others is done from this contextualized perspective. We engage one another in hermeneutic discourse where our horizons of understanding are fused with others and thereby expanded. We don't require extreme specification of one another's conceptualizations. In conveying meaning to others we make use of metaphor, imprecise language, and non-verbal cues from which we can create our own, newly contextualized understanding. Our experiences are such that we are constantly negotiating the contexts in which we are immersed and sharing those experiences in imprecise ways—we are always contextualized and underspecified, as it were. Yet, we are able to understand each other and share meaningful information about those experiences.

The reasons for creating ontologies as a system of categories rest with the limitations of machine information systems. In order to communicate with one another, information systems need very specific rules and structures to share data, unlike humans immersed in cultural contexts. Representation is an essential feature of computation currently conceived. What is represented and how it is represented—what is considered relevant and how it is made explicit—are choices we make as information scientists. We impose order on the information to be represented, but we do so from a reflective position, separating ourselves from the world and our immersive experience. We try to abstract that experience in constructing ontology-as-category and cast it into a particular frame.

> A representation casts a frame on the world, but this frame is a strength as well as a limitation. Stepping out of the frame is like jumping out of a hoolahoop while holding it…. We can schematically classify efforts to understand the origins of representations into two approaches: induction and selection. I propose a third alternative, which relies on interaction, construction, and communication [24].

Within computational systems, a frame provides the structure within which information can be exchanged. Structure is necessary for meaningful exchange, but it is insufficient. We might speak the same language and use the same syntactic rules, but that doesn't guarantee meaningful communication. We might make different ontological commitments that employ different assumptions, which we uncover through hermeneutic discourse—interaction, construction, and communication. Our discourse occurs in context and to which we bring an "existential *fore-structure*" as part of the 'circle' of understanding:

> …understanding always pertains to the whole of Being-in-the-world. In every understanding of the world, existence is understood with it, and *vice versa*. All interpretation, moreover, operates in the fore-structure…. Any interpretation

> which is to contribute understanding, must already have understood what is to be interpreted. (Heidegger, *Being and Time*, p. 194, H. 152).

Ontology-as-hermeneutic is a reflection of our experience of being. We don't enter the hermeneutic circle as blank slates, rather we carry as part of us the 'existential fore-structure' necessary to understand, and through which we co-create meaning as we interact with one another. The fore-structure is developed from and integrated into our personal, historical experience. And because we are being-in-the-world-with-others, the fore-structure becomes part of our shared background, our shared understanding of the contexts in which we interact. Heidegger's fore-structure is what we describe as a network of cognitive schemas, some of which we share as cultural schemas. They are experiential and emergent rather than analytically reflective. They are continually evolving, adapting and changing, though not chaotic. Rather they are relatively stable, but with tolerance for variability and ambiguity. In taking a perspective of ontology-as-hermeneutic, our ontologies *are* our cultural schemas.

COGNITION AND CULTURAL MEANING

In cognitive science, connectionist theory posits the human conceptual system as a network composed of a large number of units joined together in a pattern of connections [25]. Cognitive anthropologists and educational psychologists refer to these patterns of connections as schemas [7, 8, 26, 27]. Schemas are strongly connected networks of cognitive elements, having a bias in activation through repeated exposure to the same or similar stimulus, but they are not rigid and inflexible.[1] D'Andrade [8] explains in more detail that schemas are "flexible configurations, mirroring the regularities of experience, providing automatic completion of missing components, automatically generalizing from the past, but also continually in modification, continually adapting to reflect the current state of affairs." Describing them as 'flexible, mirrored configurations' implies that schemas are structural entities within cognition that are comprised of several elements. Schemas are not the individual elements rather strongly connected clusters of elements of experience within cognition. Elements of experience are clustered in cognition, in our neural networks, because they are clustered in our lived experiences. Schemas are cognitive entities that help us process information. Clustering cognitive elements makes them more efficient by reducing the cognitive load associated with processing experience.

Schemas also have other qualities. Some schemas are durable. Repeated exposure to patterns of behavior strengthens the networks of connections among the cognitive elements. Some schemas show historical durability. They are passed along from one generation to the next. Some schemas show applicability across contexts. We draw upon them to help us make sense of new and unfamiliar experiences. Some schemas exhibit motivational force. Such motivation is imparted through learning, explicitly and implicitly, strengthening the emotional connections among the cognitive elements. Schemas have a bias in activation through repeated exposure to the same or similar stimulus, but they are not rigid and inflexible. They are adaptable, sometimes resulting in the strengthening of existing schemas, sometimes in their weakening in the face of new experience.

Schemas are the cognitive element in the "structural coupling" of our experience as described by Winograd and Flores (1987). Schemas are powerful processors of experience, help with pattern completion, and promote cognitive efficiency. They serve to both inform and constrain our understanding of experience. Because of their functionality in pattern completion, schemas function, in some sense, as flexible filters of experience, enabling us to attend to its salient features while filtering out the non-salient. People recall schematically embedded information more quickly and more accurately [28]. In fact, schemas hold such sway in our cognition that people may falsely recall schematically embedded events that did not occur. They are more likely to recognize information embedded in existing schemas because of repeated activation of the patterned cognitive elements.

Repeated activation evokes expectations within cognition, and the easy recognition or dismissal of contradictory or challenging information that do not conform to those expectations formed as part of the existing schemas. Information that is orthogonal to existing schematic structures, that doesn't acquire salience through the repeated activation of schemas and the creation of associated expectations, is much less likely to be noticed or recalled. Unless, of course, orthogonality becomes the focus of the experience such as when we are working to expand our horizons of understanding through discourse. In this situation we are attuned to the divergence between our shared schemas as we try to close the distance between our conceptualizations and those of others. Or, as Heidegger might say, we are always attending to the breaking down of experience.

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[1] They have also been referred to variously in the literature as frames, scenes, scenarios, scripts, models, and theories (D'Andrade, 1995).

Schemas, as complex cognitive associations, are intrapersonal structures. The objects or events that are manifest outside individual cognition, the entities in the external world, are extrapersonal structures. It would be inaccurate to say that schemas are separable from culture, for that would imply that culture consists solely of the external world structures outside the individual. Culture consists of the interplay between the intrapersonal cognitive structures—Hiedegger's existential fore-structures—and extrapersonal structures such as systems of signs, infrastructure, environment, social interaction, and so on—Heidegger's *ready-to-hand* background. The intrapersonal and the extrapersonal are different and distinct, but closely interconnected. They are not isolated from one another, rather separated by a permeable boundary—one that blurs the distinction between subject and object. Culture encompasses both intrapersonal and extrapersonal structures and emerges from the interplay between them. It is through this interplay that we can see that some of the intrapersonal cognitive structures called schemas are shared. The notion of schemas marks a shift away from the focus on deliberative and explicit cognitive processes, which mirror the ways we deal with language in cognition (and formal ontology artifacts), to thinking and cognition as automatic and implicit. It is the shift away from symbolic processing models of cognition toward a connectionist model of cognition, a shift from ontology-as-category to ontology-as-hermeneutic.

Shared schemas as cultural schemas

The sharing of schemas does not require people to have the same experiences at the exact same time and place, rather that they experience the same general patterns. As beings in the world, we organize our experiences in ways that ensure ease of interaction, coordination of activities, and collaboration. Because we organize our experiences in particular ways, people in the same social environment will indeed experience many of the same typical patterns. In experiencing the same general patterns, people will come to share the same common understandings and exhibit similar emotional and motivational responses and behaviors. However, because we are also individuals, there can be differences in the feelings and motivations evoked by the schemas we hold. "The learner's emotions and consequent motivations can affect how strongly the features of those events become associated in memory" [7]. Individuals will engage the external world structures and experience the same general patterns. Similar stimuli and experiences will activate similar schemas. It is in that sense we considered them shared schemas. It's their quality of sharedness that makes them a dimension of the cultural.

We share the intrapersonal dimensions of culture when we interact with others. In sharing these intrapersonal dimensions, schemas are activated. Activation evokes meanings, interpretations, thoughts, and feelings. The cultural meaning of a thing, which is distinct from the personal cognitive meaning, is the typical interpretation evoked through life experience, with the acknowledgement that a different interpretation could be evoked in people with different characteristic life experiences. In some cases our experience is intracultural, where we share a similar cultural frame. In other cases our experience is intercultural, where we are sharing different cultural frames. The meanings evoked by one person in relation to a particular extrapersonal structure may not be the same as those evoked in another. In fact, the meanings evoked may not be the same within the same person at different times, for they may experience schema-altering encounters in the interim. The ways in which we share these intrapersonal dimensions of culture makes each person a junction point for an infinite number of partially overlapping cultures.

The Importance of Identity

The notion of identity and multiplicity of perspectives is important in our understanding how cultural schemas manifest. Individuals can manage multiple identities in the same or multiple contexts. We can shift our perspective effortlessly between national, familial, peer and other identities to make sense of particular phenomena (i.e., frame it in relation to ourselves) [29]. The same context, for example, that would be considered "exciting" to "the hunter" might also be "dangerous" to "the parent." Fauconnier and Turner [30] claim that "frames structure our conceptual and social life and, in their most generic and schematic forms, create a basis for grammatical construction." Words are themselves viewed as constructions, and lexical meaning is an intricate web of connected frames. They also claim that although cognitive framing is reflected and guided by language, it is not inherently linguistic—people manipulate many more frames than for which they have words and constructions. It is the individual's salient, contextualized identity in relation to the phenomena that allows for sense making of the phenomena. When making meaning of a particular phenomenon, individuals will rely upon the cognitive and cultural schemas that are integral parts of their salient, contextualized identities.

Knowledge embodied in conceptual systems and reflected in language is in fact deeply ensconced in culture [7, 8]. Our interpretation of reality is dependent upon our cognitive structures and our cultural and contextual backgrounds; all associations of perceptual input to cognitive concepts depend on our pre-understanding of the context [6, 31]. Our cognitive schemas shape the associations we make of our perceptual input.

Culture and ontological commitments

The construction of ontologies by information scientists is an attempt to overcome the Tower of Babel problem by providing a common dictionary of terms and definitions within a taxonomical (i.e., relationship) framework for knowledge representation that can be shared by different information-systems communities [4, 32]. However, theories of being, of what exists, are not defined by a common vocabulary, rather they are dependent upon particular perspectives and ways of understanding the world in which we are immersed. What exists is dependent upon our cultural schemas.

We can illustrate this point with a simple, yet high-contrast, question: Is that rock mound in the West Australian desert a granite composite with specific Cartesian dimensions or is it Krantjirinja, my Kangaroo Ancestor? The answer to that question is dependent upon the cultural schemas of the person being asked. For the geographer, the mound is a rock formation, composed of slate and situated on a Cartesian grid, which he can map and represent in a GIS. For the Krantji, an aboriginal group on whose land the mound is situated, it is Krantjirinja, their Kangaroo Ancestor, who has existed since and continues to exist as part of the Dreamtime, and who sits along a path commonly known to outsiders as a Songline. And they see not only Krantjirinja but also his influence on the surrounding landscape. The Krantji clan does not see a rock formation when they look at the mound—it doesn't exist—just as the geographer doesn't see Krantjirinja. Not only are geographic entities identified constructed culturally, but the relationships between entities in geographic space also are associated in different ways by different cultures [33, 34]. In making meaning of this mound, each uses the cultural schemas they have developed through their cultural immersion. They literally see completely different entities situated in completely different backgrounds.

What happens if a member of the Krantji clan becomes a geographer? To become a geographer one must have a particular type of training or education. One does this through a process of acculturation, where one is exposed to and assimilates the ideas, concepts and understandings of other geographers. The Krantji clan member doesn't come to the acculturation process devoid of experience or worldview, rather with a set of cultural schemas she uses to understand the geographic landscape. In learning the new cultural schemas of geographers, she will acquire new cultural schemas and possibly blend them with her Krantji cultural schemas [30]. Or, she could compartmentalize the two sets of cultural schemas, which would be evoked in different and separate experiential contexts [29]. Once she has acquired the cultural schemas of geographers, she may be in a unique position to translate between the ontologies of the two cultures. Perhaps she discovers that what connects the two ontologies is not the outward appearances of a rock mound and a Kangaroo Ancestor, but its location as the primary source of water and the determinant of the hydrologic cycle of the area—important to the cultural schemas of the physical geographer—as well as those of the Krantji clan who think of it in terms of the power and influence of their ancestor, which is intimately linked to ecological conservation and survival. The rock mound and the ancestor may simply be the entry points into the complex ontological associations that we as humans engage in a hermeneutic process to uncover. Employing ontology-as-hermeneutic allows us to create bridges between sets of different cultural schemas—different ontologies—to create a new shared cultural schema that the bicultural Krantji geographer would be in a unique position to facilitate.

Cultural schemas are, in essence, our ontologies. They shape our ontological commitments to what exists in the world as well as the ways in which we approach and engage the world. And while they help structure our understanding of the world in which we are embedded, they are associative and flexible. They help to focus our attention to particular details of our experiences and give them salience. They allow us to make meaning of the contextualized, cultural experience in which we are always immersed. Formal ontologies constructed as taxonomic structures and categories of an objective world, however complex and inclusive of relationship axioms, will not work across cultural boundaries because they rest on different ontological conceptualizations and commitments. They crystallize a single perspective into the ontology artifact as representative of what exists. They short-circuit the dialogue that humans engage in as part of their semantic negotiations about their ontological commitments. Moreover, they work only in limited degree across individual or intracultural boundaries. Humans think and communicate in very flexible and schematic ways, and ontologies should reflect this flexibility and the adaptive nature of human cognition in order to achieve semantic interoperability. In order to do so, we must forego the comfort of a rationalist worldview that presumes an objective external world as well as its logical opposite, solipsism. We need to reach beyond the lexical and syntactic in constructing our machine ontologies that rely on symbol processing and extend their grounding to the phenomenological and hermeneutic—embed within them the ability to negotiate meaning through a hermeneutic process. Casting culture as an emergent phenomenon, and cultural schemas as the complex networks of conceptualizations that comprise our ontologies, allows us to ground ontologies on a phenomenological footing.

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