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Outlines of a Model of General Ontology*

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Abstract

This article outlines a new model of general ontology that draws significantly on the results of contemporary philosophy and cognitive science. It combines ideas from Gärdenfors's Conceptual Spaces Model and Edmund Husserl's philosophical insights concerning ontology and dependency. We put forth a possible architecture for general ontologies based on a "horizontal" (dependency-based) and a "vertical" (abstraction-based) arrangement of the concepts in the ontology.

Keywords: general ontology, conceptual spaces, modal dependence

1 Introduction

According to Thomas Gruber's oft-cited slogan, an ontology is "an explicit, formal specification of a conceptualization" which is mutually accepted by the communicating agents [4]. While this characterization can be met relatively easily in the case of narrow-scope domain ontologies, large-scale general ontologies pose special problems. In particular, in the case of general ontologies:

- What is meant by "mutual acceptance"?
- What is meant by "conceptualization"?
- How should "an explicit, formal specification" of a general ontology be construed?

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The structure of the paper is as follows. In **Section 2** we describe Peter Gärdenfors's Conceptual Spaces Model, which we hope provides a putative answer to the first two questions above. The rest of the paper is devoted to answering the third question. In **Section 3** we enlist a set of meta-properties and a distinguished relation (called *dependency*) which is inspired by Edmund Husserl's seminal work, on the basis of which a general ontology can be organized. We also give a concrete example as an illustration. In **Section 4** we briefly discuss some questions pertaining to the particular choice of ontology description language (more specifically, AVM's or DL's). Finally, **Section 5** provides a short summary of the paper.

2 The Conceptual Spaces model

In the case of general ontologies, *mutual acceptance* is guaranteed by the high degree of similarity between the cognitive structures of different members of the human kind. Therefore we may turn to the cognitive sciences for a theory of such structures. A recent and quickly developing branch of cognitive science has abandoned those mechanisms that only assume purely symbolic representations; instead, it operates on broader assumptions that fully acknowledge the importance of the spatial element in human reasoning. This approach is eminently exemplified in the Conceptual Spaces model, developed by Peter Gärdenfors in, for instance, [3], whose philosophical forerunner is Robert Stalnaker's [10]. Stalnaker's goal was to work out an alternative foundation of modal logic. According to Stalnaker, any entity, whether actual or possible, can be represented as a vector in an abstract space whose dimensions are the independent properties that can be predicated of the entity. For example, a particular red ball b with a radius of 3 cm may be localized in a two dimensional space one of whose dimensions consists of all the possible colors and the other one consists of all the possible radii. In this space b is identified as being at the tip of a position vector whose projection on the color dimension falls in red and its projection on the size dimension falls on the value of 3 cm. It is easy to see that in this space each and every position vector determines a possible object — a concrete ball with a particular color and size. This simple example also shows the connection of the model with the traditional symbol-based approach. For instance, the complex property (concept) "to be a red ball with a radius of less than 4 cm" will be represented as a set of points P in this two dimensional space, and the proposition that b has this property simply translates into checking whether the position vector of b ends in region P or not. Similarly, to the concept "to be a red ball with some radius" there belongs a region $P' \supseteq P$, and the relationship between the two regions further makes it possible to establish the inference that any red ball with a radius less than 4 cm is a red ball as well. This approach has other forerunners in philosophy beside Stalnaker's. The theory, according to which any physical entity can be seen as the collection of its properties, is known in the history of philosophy as *trope theory* [9]. The tropes of a particular entity are those "pieces of property" that belong to it at a particular point in time; for example, the specific color of a particular rose at a particular time. Since the same trope cannot belong to different objects, the fact that two roses are exactly of the same color may be expressed by saying that the color tropes belonging to the roses are perfectly similar (without being identical). In the present approach we take tropes to be primitive entities, the bundles of which make up complex objects (e.g., physical objects). (In this we are following the DOLCE Ontology [8].)

Gärdenfors builds his theory on the philosophical base described above. But he also wants to put empirical content into Stalnaker's ideas. According to Gärdenfors, the inherent organizing principle within the particular dimensions is *similarity*, that is, the more similar two properties, say, shades of color, are, the closer they are located in the color dimension. He also proposed a method resembling factor analysis for identifying the set of relevant dimensions (see [3] for details). However, in the project we mentioned at the beginning, we chose to identify the relevant dimensions manually, since our task was to organize various lexical material (several word-meanings) in a coherent way, so we could borrow the methods of componential semantics (see e.g. [7]).

Gärdenfors, following Stalnaker, identifies concepts with regions in the conceptual space. On the basis of similarity as the main organizing principle of cognitive dimensions he is able to derive some very general features of human cognition concerning, e.g., learnability, but since that issue is beyond the scope of the present article, we refer the interested reader to the works cited above.

It is an important fact concerning dimensions that their values are linearly ordered. Strictly speaking, this is not a necessary condition (certain dimensions might have a different structure), but more often than not they are indeed linear, so we adhered to this assumption in our work.

While our theoretical commitments are similar to those of the DOLCE ontology, there are important differences. For example, whereas DOLCE is primarily a theory of top level categories, we are equally interested in lower level concept descriptions. Because of this, we had to find answers to questions that the writers of DOLCE did not have to face.

3 The structure of a general ontology

A general ontology is a description of the various connections between general concepts, that is, a system of concepts. A system of concepts is, therefore, a relational structure over the set of the concepts involved. These relations can be sorted in two broad types: the horizontal and the vertical. Let us start with the former.

3.1 Horizontal organization

Under *horizontal organization* we mean the necessary (essential) connections, or dependency relations, to be more accurate, between the various types of entities that concepts of the ontology denote. For example, such is the fact that for any instance of color there corresponds a particular instance of surface on which it appears. An instance of color depends on an instance of surface in the sense that it could not manifest itself without the latter. This also means that this relation is necessary: each instance of color necessarily involves the existence of a corresponding instance of surface. This example also illustrates the fact that dependency relations need not be asymmetric, since one could also argue that an instance of surface also necessarily implies the existence of an instance of color. An example in which symmetry obviously does not hold is the following: each event of wedding essentially depends on the existence of a bride, while the dependency naturally does not hold the other way round (a bride can exist without ever participating in a wedding). Relations like this exemplify the highest level of connections between concepts, which are conceptually necessary, and thus do not tolerate exceptions. These, therefore, form the most general layer of ontology. This approach to ontology is traditionally attributed to Edmund Husserl [5], and there have been recent attempts at laying the dependency relation on stricter, mathematical foundations, notably by Kit Fine [2]. In the sequel, however, we are going to follow a simpler method, which is more suitable for our goals, than Fine's formalism.

3.1.1 A formal characterization of the dependency relation

It would be beyond the scope of this article to attempt an exhaustive characterization of the dependency relation. In what follows, therefore, we will only put a *necessary condition* on this type of relation, which is meant to filter out at least some of the relations that are not dependency relations. Let A, B be two arbitrary types of the ontology (e.g., the concepts of surface and of color). If R is a dependency relation between A and B, then R has to observe the following condition:

$$\Box\forall x(x \text{ } \mathsf{instanceOf} \text{ } A \rightarrow \exists! y(y \text{ } \mathsf{instanceOf} \text{ } B \wedge R(x,y))). \tag{1}$$

In words: it is *necessary* that for any instance x of A, there exists exactly one instance y of B, such that x is in relation R with y. (This basically means that R is necessarily a function from A to B.) In natural languages dependency relations are often expressed by the genitive case (e.g., *color of*, *shape of* etc.), but — as shown by the example of the wedding — this is more of a tendency than a rule.

The conceptual and intensional character of the meta-predicate "dependency" is guaranteed by the presence of the '$\Box$' (the necessity operator). Thereby, given that there are various degrees of necessity, we arrive at dependency relations of different strength. In the case of the connection between color and surface above, we saw an example of the so-called metaphysical necessity. This type of necessity is extremely strong, almost of logical strength. Let us now consider a weaker type of necessity and the dependency relation based on it: if, for instance, $\Box$ is construed as "it is necessary according to the laws of biology that", and A is identified as the type of man and B as the type of woman, then

$$\Box\forall x(x \text{ } \mathsf{instanceOf} \text{ } \mathsf{man} \rightarrow \exists! y(y \text{ } \mathsf{instanceOf} \text{ } \mathsf{woman} \wedge \mathsf{mother\text{-}of}(x,y)))$$

will be true, whereas

$$\Box\forall x(x \text{ } \mathsf{instanceOf} \text{ } \mathsf{man} \rightarrow \exists! y(y \text{ } \mathsf{instanceOf} \text{ } \mathsf{woman} \wedge \mathsf{sibling\text{-}of}(x,y)))$$

will be false. In other words, the mother-of relation may be a dependency relation between the types of man and woman (since it is biologically necessary that every man has a mother), while the sibling-of may not be one, since it is not biologically necessary for a man to have a sister. The moral of the example is that using '$\Box$'-es of various strength, we arrive at different degrees of dependency, which renders it possible to have a smooth transition from the most general conceptual structures to the more specific ones, which apply within the domains of different professions.

It should be noted that if R is chosen to be the identity relation, then the resulting

$$\Box\forall x(x \text{ instanceOf } A \rightarrow \exists! y(y \text{ instanceOf } B \wedge x = y)) \iff$$
$$\Box\forall x(x \text{ instanceOf } A \rightarrow \exists! y(x \text{ instanceOf } B)) \iff$$
$$\Box\forall x(x \text{ instanceOf } A \rightarrow x \text{ instanceOf } B)$$

formula is the familiar generic (isa) relation between A and B. Indeed, identity may be seen as a *trivial* form of dependency, because any entity tautologically depends on itself.

From the foregoing discussion, lessons relating to the *formal specification* can also be drawn: we need a sufficiently strong graph description language to describe dependency relations. In order to decrease the strength of the language used for describing the various types, information relating to possible circular or symmetric dependencies is distributed throughout the whole of the ontology, rather than packed in just the given concept descriptions. Thereby, although particular concept descriptions are formalized with DAG's (*directed acyclic graphs*), potential circular dependencies can be restored through comparing information stored in the different concept descriptions of the ontology. In the examples below, we will be using AVM's (*Attribute–Value Matrices*) to describe DAG's, but it should be noted that research is currently being conducted to determine the appropriate language (primarily in the area of Description Logics [1], see Section 4). Nodes representing particular types will thus correspond to matrices and eventually values (variables, tropes or even whole regions of dimensions), while edges will correspond to attributes. An attribute–value pair A_i–V_j in the matrix of a given type T is interpreted as the necessary existential implication discussed above stating that there is exactly one value of type V_j belonging to T such that it is in relation A_i to it.

3.2 Essential and contingent properties

Dependency relations belonging to a given type include necessary constraints pertaining to the individuals of the relevant type. For instance, no event *can ever be* an instance of wedding unless an actual instantiation of the bride's role by someone can be identified.

Our knowledge about reality, however, can be grouped into two classes. One class comprises the above-mentioned *a priori* (conceptually necessary) connections, while the other one includes *a posteriori*, or contingent connections. A priori, or necessary connections belong to the net that — according to Wittgenstein[1] — we lay upon reality in order to be able to manage the originally formless "mass". The laws of this net are, therefore, the laws of language and logic. However, what actually fills the meshes of the net depends on the characteristics of actual reality, and is therefore contingent. A general ontology should also be able to depict the contingencies characterizing our world.

Traditionally, the necessary properties (features) of individuals are called essential properties, and have already been discussed extensively above. Essential and contingent traits, however, are of course linked. For example, the fact that there is always some actual color belonging to every actual surface (in the macro-sized world) is necessarily true, but this statement, naturally, does not specify that this color be, for instance, red. Which color the given surface will actually possess will depend on the contingent properties of reality. Similarly, it can be essential for an individual belonging to a certain type that the value of one of its properties fall into a given interval, while which value it specifically possesses, may be solely contingent.

Using our general concepts, the meshes of the "purely a priori net" can be divided into smaller units. In these smaller "compartments", various types of experience may possibly be present. Experience, however, cannot contradict the "geometry of the net", which is defined in the a priori statements, but it can contain elements, though, that characterize with a substantial probability the objects to be found in the given mesh of the net. These empirical generalizations that are allowed to make an exception render us capable of making default inferences, which can, of course, be "contradicted" by actual instances. Such a generalization with only default force is called a *proprium* in the present study. Below, we are going to elaborate on this and other concepts relating to contingency.[2]

3.3 Contingent properties

Contingent properties can be subdivided according to how stably they characterize a certain object in time. First let us define the class of contingent properties in general (accidences), then we will proceed to the definition of proprium and phase, its subclasses.

Accidence A property $\mathcal{A}$ is accidental in c, if c possesses $\mathcal{A}$, but not necessarily so; in other words, if it possible for c to exist but not possess $\mathcal{A}$.

During the existence of the entity c, there *may* be periods when it does not possess $\mathcal{A}$. There need not, however, be such periods. c might possess $\mathcal{A}$ during all of its

[1] "Although the spots in our picture are geometrical figures, nevertheless geometry can obviously say nothing at all about their actual form and position. The network, however, is purely geometrical; all its properties can be given a priori. Laws like the principle of sufficient reason, etc. are about the net and not about what the net describes." (Tractatus Logico-Philosophicus: 6.35.)

[2] The terms "concept" and "type" will henceforth be treated as synonyms — allowing for some sloppiness.

existence by chance without it being necessarily and inevitably the case that it *has* to be so. This justifies introducing the concept below.

Proprium A property $\mathcal{P}$ is a proprium of c at t, if it characterizes c during all or most of the moments of its existence up to t, but is not an essential property of c.

Whether a property $\mathcal{P}$ characterizes c as a proprium cannot be decided based solely on the present temporal slice of c, but only by taking all of c's history (up till now) into consideration. A proprium is an inductive generalization based on the history of c ("c has so far been mostly characterized by $\mathcal{P}$"). Consequently, c may be lacking the property $\mathcal{P}$ at a given moment without $\mathcal{P}$ ceasing to be a proprium of c. If, on the other hand, c has been lacking $\mathcal{P}$ during most of its history, $\mathcal{P}$ is not a proprium of c.

The difference between an essential property and a proprium is the difference between the necessary and the probable, and — accordingly — while an essential attribute does not tolerate exceptions in time, a proprium does so to a certain extent. "Proprium" therefore, is an umbrella term for trend-like properties characterizing an entity persistently but not necessarily. Features that characterize an entity only briefly and temporarily, during a small stretch of time, form the subject of the next subsection.

3.3.1 Phase

The term "phase" is a back-formation of "phase space" known from physics. The phase- or state space consists of dimensions called "degrees of freedom", in which all the possible states of a system are represented such that for every possible state of the system there is exactly one point corresponding to it in the phase space. A not at all far-fetched *analogy* can be drawn between this concept and Gärdenfors's concept of cognitive space, in that the degrees of freedom of the system correspond to the dimensions of the cognitive space. The analogy is as follows.

The degrees of freedom of a system correspond to the properties that can in principle be predicated of the entity. If we project the trajectory covered by the system during its existence on the relevant degrees of freedom, the projections which the system cannot possibly leave correspond to the the range of its essential properties. Projections of the trajectory covered by the system during its existence up to t, in which the system resides "most of the time during the temporal interval from the coming into existence of c to t", correspond to propria. Finally, states which the system occupies at a given moment correspond in ontology to what we have called phases in the present paper:

Phase The properties $\mathcal{F}$ that an entity c possesses at a given time are called c's phases.

The relationship of the above meta-concepts are illustrated in the table below.

	stable in time	instable in time
necessary	ESSENCE	—
not necessary	PROPRIUM	PHASE

In the foregoing discussion, the terms “proprium” and “phase” were defined as applying to *individual entities*. However, drawing on this, analogous definitions can be established for types. A proprium of a given *type*, for example, can be thought of as all those properties that are (individual) propria of most of the actual instances belonging to the relevant type. Similarly, the concept of a phase could be extended to types, but since the value for use of this concept is rather limited, this extension will be omitted here.

3.4 Vertical organization: three levels

Based on the distinctions drawn up above, three levels of the concept nodes in the ontology can be distinguished vertically (going downwards):

level	name	components
I.	Essential concepts	essences
II.	General concepts	essences and propria
III.	Individual concepts	essences, propria and phases

3.4.1 Level I. (essential) concepts

These describe the characteristics of the “linguistic–logical net”, and are, therefore, a priori. Relations defined by these are deemed necessary; in other words, we adhere to their truth irrespective of what form reality is taking. An example for such a constraint is that (macro-)physical entities — beside numerous other necessary attributes — possess a surface and mass:

$$\textsc{physical-entity}\begin{bmatrix} \vdots & \\ \textsc{surface} & \boxtimes \\ \textsc{mass} & \boxtimes \\ \vdots & \end{bmatrix}$$

This can be interpreted in the following way: For any instance of the concept of PHYSICAL-ENTITY, there corresponds some instance of the concept of SURFACE, some instance of the concept of MASS etc. The actual value of the type assigned to it by the dependency relation cannot be specified at this point, of course, since that is contingent.

In the same way, we know a priori that a surface necessarily has a color, shape and extent (and the list may include further elements):

$$
{}_{\text{SURFACE}}\begin{bmatrix} \vdots & \\ \text{COLOR} & \boxtimes \\ \text{SHAPE} & \boxtimes \\ \text{EXTENT} & \boxtimes \\ \vdots & \end{bmatrix}
$$

In other words, to any instance of the concept of SURFACE, we can assign an instance of COLOR, an instance of SHAPE, an instance of EXTENT etc. Obviously, necessarily obligatory features of a necessarily obligatory feature are also necessarily obligatory:

$$
{}_{\text{PHYSICAL-ENTITY}}\begin{bmatrix} \vdots & \\ \text{SURFACE} & \begin{bmatrix} \vdots & \\ \text{COLOR} & \boxtimes \\ \text{SHAPE} & \boxtimes \\ \text{EXTENT} & \boxtimes \\ \vdots & \end{bmatrix} \\ \text{MASS} & \boxtimes \\ \vdots & \end{bmatrix}
$$

All of the above are level I. concepts, since they only include *purely* modally necessary relationships.

3.4.2 Level II. (general) concepts

An example for a general concept is the concept of “cat”. The description of a general concept comprises two kinds of information:

1. essential information
2. contingent information

A general concept rigidly inherits all essential information from level I. concepts above it. For example, every instance of the concept of “cat” is a physical entity, hence, the concept of CAT — or to put it more accurately — the description assigned to the node belonging to the general concept of CAT will include everything that necessarily characterizes physical entities. At the same time, a general concept may include further essences, as well —for example, that the body temperature of a cat cannot be 15000°C; this we know for sure without there being any need for performing experiments to that effect. It is easy to see at this point, though, that what we are dealing with is a weaker — biological — kind of necessity, since it is not in itself logically contradictory to assume that a cat remains a cat even at 15000°C, whereas it is contradictory to hold this based on our knowledge of biology. That we still wish to regard this as essential information is justified by the fact that common-sense (and presumably, scientific) thinking both deem a creature functioning at 15000°C *impossible*. We will thus consider it an essential feature of CAT that its BODY-TEMPERATURE *should* fall between 35.0°C and 42.0°C, because should it leave this range, it will cease to exist.[3]

Contingent information characterizes most of the instances, but conceivably not all of them. A piece of information like that is the fact that the BODY-TEMPERATURE of CAT takes its value from the value range 39.0 ± 0.2°C, given that the body temperature of the majority of cats falls into this range at almost every moment, which makes it a proprium. A proprium is not necessary in any respect, being merely a result of a generalization based on the actual instances of the concept, which means that a proprium can never contradict a constraint that is regarded essential.

Propria of general concepts are not necessarily generalizations based on a single person's own experience, but rather codify the accumulated experience of (the professionals of) a community. Through the mediation of culture, however, community-level experience relating to the various types of being are built into the conceptual representations of each person as contingent — but very probable — world-knowledge.

Since propria assigned to general concepts are not a priori necessities, they are subject to *default inheritance* between nodes. For example, although the BODY-TEMPERATURE of CAT ranges between 39.0 ± 0.2°C, that of the ANGORA-CAT ranges between 39.5 ± 0.1°C.[4]

[3] This information is inherited by CAT from MAMMAL in a more elaborate version of this example.
[4] The data, of course, only serve illustrative purposes.

$$\text{CAT}\begin{bmatrix} (\text{ESSENCE}) \begin{bmatrix} \vdots & \\ \text{SURFACE} & \begin{bmatrix} \vdots & \\ \text{COLOR} & \cdots \\ \text{SHAPE} & \cdots \\ \text{EXTENT} & \cdots \\ \vdots & \end{bmatrix} \\ \text{MASS} & \leq 20.0\text{ kg} \\ \text{BODY-TEMPERATURE} & 35.0 \leq T \leq 42.0^\circ\text{C} \\ \vdots & \end{bmatrix} \\ (\text{PROPRIUM}) \begin{bmatrix} \vdots & \\ \text{MASS} & 3.5 \leq m \leq 4.5\text{ kg} \\ \text{BODY-TEMPERATURE} & 39.0 \pm 0.2^\circ\text{C} \\ \vdots & \end{bmatrix} \end{bmatrix}$$

3.4.3 Level III. (individual) concepts

An individual concept describes a specific individual, for instance, a specific cat, say, Felix. The essential features of the individual concept FELIX will be the most specific essential features of the concepts above it, which it cannot overwrite.

Propria attributed to FELIX are *double-layered*: part of them is inherited with default inheritance from the general concept immediately above it[5], and the rest of them are propria that are *individual propria*, characterizing only FELIX. For example, if Felix spends most of his time on the mat in front of the door, then this will be an individual proprium characterizing his individual concept — but not the general concept of CAT.

Finally, Felix might be in specific *phases*, as well, and the values for these phases can contradict both his individual propria and his general propria. Phases, however, can even become individual propria of Felix with time (and if it happens for a substantial amount of cats, a proprium assigned to the general concept of cat may also undergo change). According to the description below, for example, at 14:00, Felix was lying in his litter with a fever — based on his body-temperature.

[5] Thus Felix may overwrite these general propria.

$$
\textsc{Felix}\begin{bmatrix}
(\textsc{essence}) & \begin{bmatrix} \vdots & \\ \textsc{surface} & \begin{bmatrix}\vdots & \\ \textsc{shape} & \cdots \\ \textsc{extent} & \cdots \\ \vdots & \end{bmatrix} \\ \textsc{mass} & \leq 20.0\text{ kg} \\ \textsc{body-temperature} & 35.0 \leq T \leq 42.0^\circ\text{C} \\ \vdots & \end{bmatrix} \\
(\textsc{proprium}) & \begin{bmatrix} \vdots & \\ \textsc{color} & \text{red} \\ \textsc{mass} & 4.8 \leq m \leq 5.0\text{ kg} \\ \textsc{body-temperature} & 39.3 \pm 0.2^\circ\text{C} \\ \textsc{place} & \text{mat} \\ \vdots & \end{bmatrix} \\
(\textsc{phase}) & \begin{bmatrix} \vdots & \\ 14{:}00 & \begin{bmatrix} \vdots & \\ \textsc{mass} & 4.88\text{ kg} \\ \textsc{body-temperature} & 40.1\text{ C} \\ \textsc{place} & \text{litter} \\ \vdots & \end{bmatrix} \\ \vdots & \end{bmatrix}
\end{bmatrix}
$$

4 A possible formalization

As can be seen from the previous discussion, our model of ontology builds basically on graphs. Consequently, the ontology can be described using a graph description language. In our preliminary work at describing concepts of common sense, we began using AVM, which are a common tool in linguistics. However, this choice is, as yet, arbitrary, and basically any graph description language would be suitable.

An issue that can be raised is how our chosen language (in this case, AVM's) relates to description logics — a common tool used in ontologies.

Comparing DL and our model, one issue that arises is that while even the most basic Description Logics include the negation or complement operator, implementing negation is not so straightforward in our model. AVM's used in linguistics usually prohibit negation and disjunction (however, see e.g., [6], [11]), and it may be argued that these operators are not needed when creating common-sense ontologies.

Another difference that sets our model and DL apart is that Description Logics that do not use role chains have a considerable deficiency in describing some complex concepts that make reference to the token identity of two concepts standing in a certain relation to the given concept. To give a very simple example, the mother-in-law of a man is identical to the mother of his wife. This can only be translated to a DL if it includes role-value-maps and the concept agreement operator (cf. [1]). However, these versions of DL are only decidable if they restrict the roles in the role-value-maps to functional roles. (R_F is a functional role iff $\{(a,b),(a,c)\} \subseteq R_F \rightarrow b = c$.) Models using AVM's usually assume attributes to be functional attributes, but when building an ontology, this restriction may cause some problems. The generic and mereological relations can hardly be defined as functions, and the description of some domains could easily need some non-functional relations as well.

On the other hand, the generic and mereological relations are special relations that have a distinguished role in ontologies, not to mention the fact that the generic relation is not part of the description language, but is a second-order relation between concepts.

The issue of formalization, as can be seen, is not yet fully resolved, and further research is necessary in this area. Currently, AVM's seem a suitable candidate for the role of representing dependency relations in general.

5 Summary

In this study, we have — rather roughly — presented an architecture for a general ontology. The central concept of this architecture is the dependency relation between types and the dependency graph representing it. Type relations like this constitute the horizontal structure of the ontology. The highest and most abstract level of the vertical organization of ontology comprises descriptions of "strong", logical–metaphysical kinds of dependencies. These graphs define few, but very general constraints on possible beings without tolerating exceptions. Weaker ("profession-dependent") modalities, as well as propria characterizing a given type in our world appear on the next level. Finally, on the level of individual concepts, values that have so far been underspecified will receive specification.

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