A Perspectivist Approach to Conceptual Spaces

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Abstract It is a part of everyday life that objects appear different from each perspective they are seen from. Ordinary language has plenty of expressions referring to abstract issues "from my point of view" or "your perspective". In this article, we argue for a *perspectivist* approach to conceptual spaces, that is, an approach to concepts as entities whose definition depends on the perspective from which they are considered. We propose an interpretation of Gärdenfors's conceptual space in terms of two components: a highly multi-dimensional *ontospace* whose simultaneous grasp is beyond or near the edge of human cognitive capabilities, and a lower-dimensional *representational* space that supports conceptualization of the ontospace in the manner Gärdenfors has suggested, however allowing several alternative conceptualizations, not just one. We suggest that a given ontospace is only accessible to the cognition by means of the epistemic work of exploring alternative perspectives. Further, we suggest that the overall understanding of a domain that emerges from seeing it from multiple perspectives is on a higher abstraction level than any particular single perspective. We stress that perspectives to the ontospace are individual and vary as a function of interest, situational contexts and various temporal factors. On the other hand, they are communicable, allowing interpersonally shared conceptualization.

Keywords: conceptual space, conceptualization, exploration, Gärdenfors, perspectivism, ontospace, representational space

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1. Introduction

Gärdenfors's theory of conceptual spaces (1990, 1992, 2000, 2001) has made an significant impact on today's cognitive science, not only by means of providing a bridge between symbolic and connectionistic theories and semantics. Its influence on the development of the theories of categorization, induction and the emergence of language has been important, not least due to its contribution to the prototype theory (Rosch 1973, 1975). The assumption of similarity as the foundation of concepts and categorization that underlies Gärdenfors's work has a long preceding tradition in psychology and philosophy. One of the prominent theoreticians of similarity is Shepard (1987), who associates similarity to generalization. He also remarks that the issue of similarity is much older, even dating as far back as to Aristotle (ibid. 1317).

One of the main criticisms against similarity-based cognition worth bringing to the discussion is the idea that this similarity is too vague an idea to explain cognitive processes unless there is a definite account of what counts as a quality dimension (Murphy and Medin 1985, Gärdenfors 2000, 108). This issue is closely associated with the dynamic nature of conceptualization. Gärdenfors cites (ibid, 109) Goodman who pointed out that "similarity is relative and variable" (1972, 437). This criticism, in our view, does not, however, undermine the significance of similarity, but rather makes it compelling to analyze the factors with respect to which similarity is relative. While admitting that a full model of cognitive mechanisms should include the processes that operate on representations (Gärdenfors 2000, 31), he leaves such considerations outside of the model (in 2000 and 2001), but returns later to discuss them from various angles. A systematic inquiry of geometric representation of similarity is done by Johannesson (2002), who finds several new ways to the increase the descriptive powers of geometric models, one of them being the descriptive powers of geometric models can be increased in a number of ways.

Although the conceptual model has a large degree of explanatory value, the questions remain as to *when, how* and in *which context* the concept-constituting similarity occurs. The present paper aims to contribute to the analysis of the last two questions, and at least open the issue of the first. With *how* we point to the dynamical and interactive exploration of similarities, and *in which context* we refer to perspectives that determine similarity.

For Gärdenfors, a conceptual space is determined by *quality dimensions* of which some might be innate, some learned, or culturally dependent, and some even introduced by science (Gärdenfors 1992, 4). In his approach, concepts are regions of conceptual space augmented by the geometry and metric of the conceptual space. "A key element appears to be that the knowledge representation is *non-linguistic* in the sense that "we can represent the qualities of objects without presuming an internal language in which these qualities are expressed". The qualitative dimensions are thereby ontologically prior to any form of language. This presupposes that it is possible to operate with qualities of objects without presuming a language on which these thoughts can be expressed. (See e.g. Gärdenfors 1990). This suggests that quality dimensions determine the conceptual space more or less absolutely.

Gärdenfors puts considerable effort into eliminating charges of relativism (2000, 81) and defends what we consider to be his variant of objectivism. According to him "our quality dimensions are what they are because they have been selected to fit the surrounding world" (Ibid, 83). This argument apparently addresses conditions that are determined by evolution and which may have existed before language emerged. Gärdenfors and Warglien (2007) assume that different individuals have different mental spaces and thereby set out to solve the issue of shared semantics by the "meeting of minds" in terms of synchronized fixpoints. In Zenker's and Gärdenfors's discussion on conceptual change in scientific conceptual frameworks (2015) the idea of a given or fixed conceptual space is abandoned.

We interpret that Gärdenfors and his collaborators now see conceptual spaces as a means to study any conceptual structures, even abstract ones beyond the primordial level of cognition to which Gärdenfors (2000) appears to refer. As Gärdenfors and Williams (2001) discuss, a conceptual space is a flexible approach that can be modified in various ways. We follow this suggestion by introducing a *perspectivist* account of similarity, allowing the interactive exploration of alternative perspectives to the conceptual space.

2. Perspectivism

The recognition of the perspectival nature of cognition can be called *perspectivism*, following Giere's definition (2006). By means of an analogy of the spatial physical world, where objects appear in various ways depending on the perceiver's movements and points of view, even cognitive categories and concepts vary depending on the context or frame of reference. The approach has long historical roots, dating back at least to Protagoras and Heraclitus. Protagoras's maxim "*Man is the measure of all things*" sets the focus on the human agency of cognition, while Heraclitus' idea that "everything flows" introduces the essential dynamical aspect of perspectivism. It was Leibniz who first used the very term *perspectivism,* giving it a perceptual interpretation. According to his monadology, each individual, or "monad", perceives or mirrors the world from his own perspective. Perspectivism was later strongly associated with Friedrich Nietzsche, who In *Beyond Good and Evil* claimed that "there are no facts, only interpretations". Further, according to him, "*one always knows or perceives or thinks about something from a particular perspective - not just a spatial viewpoint, but a particular context of surrounding impressions, influences, and ideas, conceived of through one's language and social upbringing and, ultimately, determined by virtually everything about oneself, one's psychophysical make-up, and one's history*" (Solomon 1996, 195; See also Magnus and Higgins 1996).

Baghramian puts it that there can be more than one correct account of how things are in any given domain (2004, Chapter 10). If so, the issue is not which perspective is correct or true, but how to explore and mutually relate multiple perspectives. Consequently, there is no need to assume that the exploration of perspectives would at some point be satisfied, or to expect the convergence of perspectives to any final or 'true' form.

Similarly, in psychology Neisser and Jopling have suggested that categorization may well be based on similarity, but that similarity itself depends not only upon perceptual similarity but even involves "theory" (1997, 169). Neisser's perceptual cycle (1976) assumes a continuous systemic interaction between objects, their perception and a cognitive schema, a kind of "theory". It is even empirically well-established that the judgment of similarity is all but deterministic (see e.g. Smith and Heise 1992, 242).

In philosophy of science, interpretations of observations are said to be theory-laden, that is, they depend on the theory adopted (e.g. Hanson 1958, Kuhn 1962, Feyerabend 1981), where 'theory' equals a particular perspective. Even the etymology of 'theory' supports this reading, with the Greek verb *theorein* referring to "to consider, speculate, and look at"[3].Another view on the multiplicity of perspectives is that of Pierre Duhem, the French scientist, who criticized the inductivism of Newton, stressing that "*An experiment in physics is not simply the observation of a phenomenon; it is, beside, the theoretical interpretation of this phenomenon*" (1962, 144). His framework, representing a kind of holism referred to as the *Duhem thesis*, expressed the following: "*An experiment in physics can never condemn an isolated hypothesis but only a whole theoretical group*" (ibid. 183.)

W.V.O. Quine later elaborated the argument, which thereby came to be known as the Duhem-Quine thesis (see Gillies 1993). He talked about "*the totality of our so-called knowledge or beliefs*" that is "*a man-made fabric which impinges on experience only along the edges*" (1980, 65). According to him, different theories, or as we may interpret them in the present context, conceptualizations, are underdetermined by experience and can be empirically equivalent. Thus, the same facts can support different, potentially inconsistent conceptualizations, each of which only partially matches the experienced reality.

Putnam's *pragmatic pluralism*, according to which the same things can be described in many different ways (see 2004), also borders perpectivism. In his linguistically oriented point of view, natural languages come with their own ontologies - entities that are talked about. He indicates that everyday language employs different kinds of discourses, subject to different standards and possessing different sorts of applications, with different logical and grammatical features - different language games (Ibid. 2004, 21-22, see also Rorty 1979).

A logical treatment of perspectivism was elaborated by Antti Hautamäki (1986), based on the concept of determinables, originally presented by Johnson in 1921 (1964). According to the Johnson, determinables are abstract names, adjectives, although grammatically they are substantival (color). Determinates or determinate values like different colors, in turn, produce logical divisions of the space of determinables. Thereby Hautamäki's study already implies the fundaments of a conceptual space.

3. Ontospace exploration model

[3] http://www.etymonline.com/index.php?term=theory

We originally introduced the perspectivist interpretation of Gärdenfors's conceptual spaces in Kaipainen and Hautamäki (2011), where we set the focus on interactive exploration of multiple perspectives during the process of conceptualization. This article focused on the variability of conceptualization (or categorization) as the function of perspectives to data taken interactively. We also related perspectives to short- and long-term contexts. Short-term contexts are constituted of narrative and situational factors and interpretative frames that are effective at the moment of observation. Long-term contexts may be as broad as natural conditions, evolution, or life-long learning. In the perspectivist spirit, the approach builds on the premise that there is no such thing as a concept without a perspective, but one is at least implicitly always present. This holds even for apparently absolute and neutral data, where there is an implicit perspective at least in the form of the choice and prioritization of determinables, applied metrics, or scalings.

Another key assumption we made is that perception and cognition, ultimately the brain, cannot effectively deal with unlimited dimensionality of the world since evolution has mainly adapted them to the constraints of the directly perceivable two- and three-dimensional aspects of the environment. Therefore, we generalize that the prerequisite of cognitive-perceptual sense making is to reduce the high (or infinite) dimensionality of the world, without feeling obliged to estimate the maximum dimensionality the cognitive-perceptual system can cope with. This is an empirical question that falls under the domain of psychology. The idea of dimensionality reduction was, of course, not unbeknownst to Gärdenfors in 2000 who put it: “going from the subconceptual to the conceptual level usually involves a reduction of the number of dimensions that are represented (221)”. However, he chose not to elaborate this further as a part of his conceptual spaces model.

In order to be able to formalize the dimensionality reduction, we make a distinction between *ontospace* **A** and *representation space* **B**, constituting what we call the *ontospace model.* This allows us to study the dynamics of concept construction within a domain or discourse and, more particularly, to compare different conceptualizations concerning it. This formulation makes a distinction between the world or subject under discussion and the observer’s perspectival interpretation of it. The ontospace represents the shared “world” constructed by joint observation, elaboration and research, but which instead of yielding to one shared conceptualization allows for a range of ways to describe the surrounding world. It can also be conceived of as a platform that allows the study of the dynamics of perspective exploration, interpersonal negotiation or deliberation between different perspectives, and the potential of higher-level knowledge beyond single perspectives emerging from the explorative activity.

Following Kaipainen and Hautamäki (2011), we start from the spatial metaphor of Gärdenfors and define *an ontospace* as a coordinate system describing a state space that specifies the dimensions with respect to which items of the topical domain vary. Let I be a set of Johnsonian (1921) determinables, corresponding to feature dimensions in Gärdenfors's model. They may also be called attributes, features, properties or qualities in other contexts. To give an example of such a set, I = {color, form, weight, length,…}. For now, we also assume that qualitative determinables can be transformed into quantitative variables, which is a standard procedure in measurement theory. Associated with each determinable i in *I* there is a set of determinate values D_i. Thus, an ontospace for a topic domain is an n-dimensional space $A=D_1xD_2x...xD_n$. Elements of *A* are n-tuples of the form $a = [a_1,a_2,...,a_n]$, where a_i belongs to D_i. Each entity x of the topic domain can be represented as a state $s(x) = a_x$ in ontospace *A*, where $a_x = [a_{x1},a_{x2},...,a_{xn}]$, of which the elements are also conceivable as the *ontocoordinates* of x. Note that s(x) determines the properties of x, assuming that properties are regions of the ontospace **A** and the state s(x) of x is a member of *A***.** There is no need to assume *A* to be fixed. Rather, it can grow and shrink depending on the evolution of the discourse, culture, or scientific paradigm, whatever it is a model of.

Suppose that there is a distance measure m_i for all determinables i, expressing the degree of mutual similarity among elements in terms of set D_i of determinate values. Here m_i is a function from A_ixA_i to the set of non-negative real numbers R^+, where $m_i(a_i,b_i)$ is equal to the distance between values a_i and b_i in set A_i. Consequently, a larger distance means less similarity in a quality dimension. In terms of visualization, an ontospace is a multi-dimensional matrix that allows numerous agglomerative or divisive hierarchical clustering algorithms to be applied, such as multidimensional scaling MDS (e.g. Kruskal et al. 1978), Kohonen's self-organizing map SOM (Kohonen 1982), principal component analysis PCA, or *Eigentaste* (Goldberg et al. 2001), insofar as they allow the representation of data elements of *A* in a representation space *B* of lower dimensionality while maintaining similarity relations in *A*. The only condition is that the applied algorithm needs to allow weighting or prioritization by means of the additional element perspective *P*, determining the dimensions with respect to which similarity relations are to be prioritized. Thus, *P* is a means of expressing relativity of the similarity relations in *A*.

A *perspective* to ontospace *A* is defined as an array $P = [p_1,p_2,\ldots,p_n]$ of weights, for all determinables i. Following Kaipainen et al. (2008) we assume that a perspective applies to a *selection of determinables* as in the treatment of Hautamäki (1986), but in this case allowing all real numbered values ranging within interval [0,1]. The weight p_i expresses the *interest* or *attention* of an observer towards the ontocoordinate i. A central notion of our approach is the transformation R_P, called *reduction function*, from the high-dimensional ontospace *A* to the lower-dimensional representational space *B*. The perspective *P* has the role of constraining R_P. As a prerequisite for this transformation, we generally assume a distance measure M in *B***,** corresponding to similarity from the viewer's viewpoint. It can defined in several alternative ways, including Euclidean distance, street block distance, and as a more general formulation, the Minkowski metric.

A reduction function R_P from *A* to *B* respects the perspective *P* and distance measures in the following way:

a) If $p_i=1$, then the distance m_i contributes fully to the distance measure M

b) If $p_i=0$ then the distance m_i is ignored by M.

c) Intermediate values $0< p_i <1$ refer to partial contributions to the distance measure M.

By means of the function R_P, objects of the domain can be categorized in a manner that reflects the adopted perspective. The exact character of the reduction function needs not to be fixed, the only constraint being that R_P is sensitive to values p_i according to conditions a), b), and c). The elements p_i of P function as *weights* a viewer gives to ontocoordinates. Zero means a total ignorance of the dimension in question.

As previously discussed, our assumption is that dimensionality-reduced mapping R_P facilitates the cognitive manageability of A. Here the ontological space A is interpreted in terms of the representational space B**,** in particular, similarity relations in A are observed by means of similarity relations in B. Mathematically, a reduction function R_P induces similarity relations in A based on similarity relations in B: if $R_P(a)$ and $R_P(b)$ are similar in B then a and b are considered to be similar. This way similarity in A is relativized to perspectives P. Thus perspectives P regulate the spatial clustering and its interpretation as a conceptual space**.** In our perspectival approach, the representational space B implies a conceptual organization of the items associated with the A. Depending on the adopted theoretical approach, the organization can be conceived of as in terms of *prototypes*, *categories*, or *tessellations* (see Gärdenfors and Williams 2004), or even *mereological relations*, in every case assuming they are perspective-relative.

Thus in our approach, the number of dimensions cannot only grow towards infinite but can also diminish dynamically over time. One can interpret that concepts (and conceptualizations) are constructed on the fly, as seen from the currently relevant perspective that reflects the particular priorities, interests, and contextual conditions relevant in the particular point of time for the particular cognizer or community.

Thus, this approach implies two ways of expressing relativity. The construction of ontospace is dependent on its cultural context, reflecting what is possible to know in the present state of the knowledge. On the other hand, the construction of representational spaces is relative to the particular viewers' conditions. The major impact of the differentiation of ontospace and representational space is that it allows interactively dynamic explorations and comparisons of conceptualizations of the same data.

4. A case study

In terms of a quasi-Linnaean example, let's assume a corpus of fauna consisting of *dog*, *pig*, *human*, *gorilla*, *elephant*, *snake* and *crow*, each occupying an ontospace determined by coordinates corresponding to the following ontodimension (property dimensions): number of *legs*, thickness of hairy *skincover*, *weight*, *intelligence*, and *speed* (Table 1). In the example data, all dimensions are scaled to range between 0 and 1. Thus, 1 corresponds to the maximum number of legs (four), and 0 to the minimum (no legs).

Table 1. The data Creatures with columns indicating the property-describing coordinates of each item within the ontospace.

	legs	skincover	weight	intelligence	speed
dog	1.000	0.900	0.322	0.556	0.917
pig	1.000	0.500	0.407	0.444	0.167
human	0.500	0.100	0.525	1.000	0.333
gorilla	0.500	1.000	0.576	0.889	0.500
snake	0.000	0.000	0.068	0.000	0.833
elephant	1.000	0.100	1.000	0.889	0.000
crow	0.500	0.800	0.000	0.444	1.000

Unlike Linnaeus' fixed taxonomies of fauna, the perspectivist approach allows the corpus to be conceptualized not only in one way but also in a number of different ways, depending on the perspective chosen by the observer. Let's consider two examples of alternative perspectives and corresponding conceptualizations. Obviously, concept names are not directly derived from the model itself, but must rely on some linguistic or cultural convention outside of the current topic. In this particular example, concepts are identified with the most typical member of the concept, i.e. the mean.

Put here Image 1

Image 1. A tree structure depicting the hierarchical conceptualization of the *Creatures* from a perspective of weights intelligence (1.0), skincover (0.5), weight (0.33), legs (0), and speed (0), as controlled by the slider positions in the left panel. The corresponding hierarchical structure of the representational space is schematized textually as an embedded list in the middle panel.

From the perspective depicted in Image 1, the domain Creatures is conceptualized in the following manner. Here, humans, pigs and gorillas together constitute a convex cluster corresponding to the concept of the '*human-like*', characterized by high intelligence, low weight, and average speed.

Zoomed out from the same perspective (Image 2), they, in turn, belong to the broader concept of the '*gorilla-like*', the intelligent ones being distinguished from the non-intelligent *'snake-like'*. Within the '*gorilla-like*', the '*human-like*' are separated from those labeled '*dog-like*', '*crow-like*' and the '*elephant-like*', with respect to the particular properties weighted by the perspective.

Put here Image 2

Image 2. A broader conceptualization zoomed out from the same perspective as in Image 1.

From yet another perspective (Image 3), humans would be associated with the concept '*gorilla-like*'.

Put here Image 3.

Image 3. Perspective with the number of legs weighted (1.0), weight (0.5) and speed (0.33), associating humans with the concept of '*gorilla-like*'.

In sum, the approach allows the epistemic exploration of a conceptual space from multiple perspectives to the same data in the perspectivist sense, giving rise to corresponding hierarchically embedded conceptualizations that satisfy the convexity condition stipulated by Gärdenfors.

5. Discussion

Similarity is not given, it is "similarity-for-us", as Popper once said (1953, 45). The suggested model aims to explain the perception of similarity from different perspectives. The association of similarity with concepts, as assumed by the conceptual spaces paradigm among others, has allowed us to talk about multi-perspective exploration of concepts. However, it is not *concept* as some kind of a static construct but rather the capability of explorative *conceptualization* that is in focus. The model suggests that conceptualization of abstract entities is reminiscent of observing artifacts in a physical space, where the appearance of the artifacts depends on the observer's distance and angle to it. There is no single two-dimensional image of a chair that would suffice to exhaust the nature of such an object, but the full understanding of a chair requires multiple perspectives of it. As in the case of exploring physical objects, there is no need to assume abstract conceptualization to be static.

It is important to emphasize that an ontospace is not "given" by the world, neither is it a perspective-independent representation of the "world". It can be seen as a culturally constructed 'archive' of all dimensions possible in the context of discussion, referring to Foucault's term (1972). Essentially, the conceptualization of the "world", manifested in the representational space, is relative to the perspective adopted.

In this context the Gärdenforsian conceptual space can be conceived of being underspecified[4], referring to both an ontospace and to an implicit perspective, under which every dimension is equally given the value 1, non-sensitive to all choices, prioritizations, scalings that have taken place during the accumulation and pre-processing of data. Our model merely makes explicit that which is implicit in conceptual spaces.

The ontospace exploration approach has already proved its feasibility in several fields of application. In Kaipainen and Hautamäki (2011) we propose an interactive application aimed to facilitate the exploration of multiple perspectives in the field of knowledge organization. It allows the user to explore a topical domain (modeled as an ontospace) from multiple perspectives in order to construct alternative conceptualizations, thereby implying a kind of multi-perspective medium. One of the obvious application areas of ontospaces is to model the

[4] Peter Gärdenfors, personal communication.

accumulation of narrative contexts during unfolding stories in narrative arts. A narrative ontospace is continuously accumulated as the story unfolds. A narrative perspective assigns weights or priorities to the narrative dimensions that are brought into focus at a particular time. This concept has been applied in the field of interactive cinema (Tikka et al. 2006, Tikka 2008, Pugliese et al. 2014). Elsewhere, a computational model of ecological learning dynamics has been proposed, based on the foundation of an explorable ontospace (Normak et al. 2012). Yet, in another direction, the ontospace exploration model has been applied as an interactive approach to clustering techniques in data analysis and visualization within the *mixed methods* paradigm (Niglas and Kaipainen 2008).

With regard to the present context, Zenker and Gärdenfors suggest that *change in importance* [of dimensions] and *addition and deletion of dimensions* characterize shifts in conceptual frameworks of science (this volume). Our model can accommodate such changes, interpreted as shifts of perspective to the implied ontospace of such frameworks (cf. Hautamäki 1986, Chapter V).

Apart from epistemic exploration of ontospaces in the service of an individual cognition, perspective-relative conceptualization can be seen as a model of how an individual can simulate another person's conceptualization of a domain, that is, to simulate another person's point of view. One possibility is to make perspectives as interchangeable media items, allowing the concretization of what is referred to as 'my perspective' or 'their point of view'. Taken further, multi-perspective conceptualization may serve as a model of *deliberation* in political or ethical domains, complying with the Deweyan tradition (see e.g. Caspary 2000), or *dialogization* of texts in the sense of Bakhtin (Holquist 1981). One may also foresee the advantages of being able to point out the perspective-dependent nature of complex and ambiguous ethical, political or philosophical domains and guide the receivers to explore the alternative views on their own instead of an authoritative perspective. Quite obviously, this bears particular potential for educational purposes.

The model not only accommodates perspective-dependence and explorativeness with Gärdenfors's conceptual spaces model, but in the bigger picture it is compatible with all similarity-based conceptualization approaches, like those presented under the label "embodied realism" by Lakoff and Johnson (1999, Chapter 6). It also turns some of the criticism raised against similarity as the basis of conceptualization to a favor (Gärdenfors, 2000, 109). The relative nature of similarity does not undermine its significance for cognition. On the contrary,, it makes it compelling to analyze the factors with respect to which similarity is relative. In addition to the remarks discussed earlier, Murphy and Medin (1985, 291) have pointed out that "*at its best, similarity only provides a language for talking about conceptual coherence*". However, is not that what concepts are for? The language they propose would alone suffice as a cause for celebration, since it is exactly the communicability and shareability offered by perspective-dependent conceptualization that allows advanced intersubjectivity and consensus. Nevertheless, we leave it to future discussions to determine to which degree the introduced model can cover the scope of meanings that have been and can be associated with the idea of concepts. Gauker's claim that similarity spaces cannot model concepts (2007) represents a conflicting definition of concepts and must therefore be left to further discussions.

Obviously, the presented model must be further elaborated to provide a more complete account of the dynamics, patterns, sequences or strategies that lead to higher understanding over time. The way to such a level goes via concrete cases and system dynamics associated with them.

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