View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by Illinois Digital Environment for Access to Learning and...

A New Perspective on Instantiation

Pawel Garbacz

Abstract

This paper develops a new perspective on the relation of instantiation. This new perspective is based on recent research in cognitive psychology, or, more specifically, on the theory of frames, which was defined by Lawrence Barsalou to capture the common features of contemporary models of human concepts. I show how this new perspective may be applied to coordinate two rudimentary mental operations: *categorization* and *conceptualization*.

Introduction

Instantiation is one of the most ubiquitous relations in any branch of science and engineering. The numeral "5" is a prime number; Mars is a planet; Urdu is an Indo-Iranian language. All such statements, either implicitly or explicitly, represent the fact that a certain particular entity exemplifies or instantiates another abstract entity—be it a class, concept, or category. Library and information science is no exception to this rule, as attested by Smiraglia (2005) and his subsequent papers. In particular, the process of assigning entities to classes in a classification system is a clear-cut example of its application.

In philosophy and formal sciences, the standard perspective on instantiation originates in the Tarskian paradigm of model theory. Within this framework, the interpretation of the sentence "Urdu is an Indo-Iranian language" resorts to the relation of set membership between the object interpreted by the term *Urdu* and the set defined by the predicate "is an Indo-Iranian language." Roughly speaking, the standard perspective on instantiation likens this notion to the relation of set membership.

This paper attempts to outline a new, alternative view on instantiation. The basis for this attempt is established by recent research in cognitive

LIBRARY TRENDS, Vol. 63, No. 3, 2015 ("Exploring Philosophies of Information," edited by Ken Herold), pp. 448–463. © 2015 The Board of Trustees, University of Illinois

psychology where the standard perspective faces serious objections that stem from both categorization experiments and theoretical considerations of a more philosophical nature. Although these objections do not explicitly supplant the standard perspective, they open a new theoretical possibility. Namely, I will employ the idea of the *frame*, which was developed by Barsalou to capture the structure of human concepts. Within this new perspective, the relation of *set membership*, which is ubiquitously used to represent the relation of *instantiation*, is substituted with a relation between a particular entity and a frame, or a set of frames, that represents a concept under which this particular falls. I show how this new perspective can be applied in library and information science (LIS) to bridge the gap between classification and categorization, whose presence was identified and described in detail by Jacob (2004).

The "Received" View on Instantiation

Each time a particular entity exhibits a certain characteristic due to an abstract class or concept, I will speak, for lack of a better term, about the relation of *instantiation*. For example, Mars instantiates the class of planets, Urdu instantiates the concepts of Indo-Iranian languages, and so on. For the sake of simplicity, I will not distinguish here among classes, concepts, and categories provided that they occur in the context of instantiation.[1] The relation is assumed to relate singular objects with abstract or universal entities without any prejudice on the ontological status thereof. In other words, I intend to remain neutral on the so-called problem of universals (Rodriguez-Pereyra, 2000).

Since such basic cognitive operations as classification and categorization occur in any branch of science, the presence of this relation is ubiquitous. Needless to say, there is hardly any evidence that instantiation is interpreted consistently across scientific disciplines. On the other hand, if an epistemic context at stake involves any kind of generalization, the usage of instantiation seems to be inevitable.

In philosophy the "received" perspective on instantiation may be traced back to standard semantics for first-order logic, which has its roots in the seminal work of Tarski (1933/1983). The bit of information about Mars being a planet may be rendered in first-order logic by means of the sentence "Planet(Mars)," where *Mars* is an individual name and *Planet* is a (unary) predicate. This sentence is evaluated as true or false with respect to a formal structure called a model (of a given language). Within this structure, the name *Mars* is interpreted as a single element (of a given universe of discourse), and the predicate *Planet* is interpreted as a set of elements (of the same universe). Then, loosely and informally speaking, the sentence "Mars is a planet" is true if and only if the element interpreted as *Mars* is a member of the set interpreted as *Planet*: "Planet(Mars) if Mars $\in$ Planet."

Obviously, if one simply identifies instantiation with set membership, one should be ready to face numerous objections, mainly of a philosophical nature, to the claim that categories are nothing more than sets, which follows from such identification. Since sets are *extensional*—that is, two sets are different only if they have different members—and categories appear to be *intensional*, an argument for the sake of the latter claim requires some sophisticated conceptual machinery; for example, the so-called Californian semantics (Oliver, 1996, p. 16).

Nevertheless, the standard semantics for first-order logic implies a perspective on instantiation, which on the one hand is ontologically less demanding than the identification thesis, and on the other seems to be a default assumption in most current philosophical debates on the relation between the particular and the abstract. This perspective may be summarized by the following claims:

- For each object and each category, the object is either an instance of the category or is not—without any in-between cases.
- Each instance of a category is always an instance of the category in the same sense and to the same degree. A similar remark can be made for nonmembers. In other words, instantiation does not come in degrees.
- One category may be more or less general than another. If this is the case, and only in this case, every instance of a less general category is an instance of the more general one.

The conjunction of these claims is dubbed here as the *"received" view on instantiation.*

Now, whether this view on instantiation is as equally ubiquitous as is the relation itself should be the topic of separate research. There are certain branches of science and engineering where, due to the impact of formal logic, this perspective is taken for granted, either explicitly or implicitly. The so-called good old-fashioned artificial intelligence approach to human knowledge is a primary example (Anderson, 2003). In particular, the technologies developed within the semantic web movement implicitly assimilate this perspective when they promote such formal languages as RDF(S) and OWL (Allemang & Hendler, 2008).[2]

A less obvious environment for the received view on instantiation is psychology, where this perspective became the basis for what is now called the *classical theory of concepts.* This theory was the basis for empirical research in psychology until the mid-1970s. Its main claims can be summarized as follows:

- For each concept, there exists a definition that provides a set of necessary and sufficient conditions for being an instance of this concept.
- For each object and each category, the object is either an instance of the category or is not, without any in-between cases.

- Each instance of a category is always an instance of the category in the same sense and to the same degree. A similar remark can be made for nonmembers. In other words, instantiation does not come in degrees (Murphy, 2002, p. 15).

Thus, the classical theory of concepts is an extension of the received view, provided that psychological concepts are on a par with philosophical categories.

The classical theory of concepts was abandoned some time ago. The beginning of its demise is usually attributed to the work of Rosch and her associates, in particular to Rosch and Mervis's (1975) seminal paper "Family Resemblance: Studies in the Internal Structure of Categories." The vast body of evidence that was collected since then entails the following counterclaims to the classical theory:

- There are objects and there are concepts, such that the former are borderline instances of the latter.
- At least for some concepts, there are typical and atypical instances thereof; moreover, typicality comes in degrees.
- The formal properties of the structures we build out of concepts are irregular and do not conform to the standard view on instantiation—for instance, the relation of subsumption between concepts are not transitive (Murphy, 2002, pp. 19–24).

Let me add a few more words on the last, rather surprising finding reported in Hampton (1982), which presents the results of two experiments that demonstrate that people categorize everyday objects in a different way than that envisaged by the classical theory. In the first experiment, a group of twenty students was challenged with a number of "category judgments" of the form "An *x* is a *y*" (for example, "A bird is an animal"). The category judgments were built out of one general term, *furniture*; five less general terms: *bed*, *chair*, *lamp*, *shelf*, and *case*; and eighty specific terms, such that each of the five intermediate terms was related to sixteen more specific ones as their superordinate. The students were asked to rate the truth of those judgments on the same seven-point scale. It turned out that they evaluated around 22 percent of the trios of judgments—*x* is *y*, *y* is *z*, and *x* is *z*—in such a way that judgments *x* is *y* and *y* is *z* were evaluated as true, but *x* is *z* was found to be false. Below are some examples of such nontransitive trios:

- A sedan chair is a chair. A chair is a furniture (piece). A sedan chair is *not* a furniture (piece).
- A car headlight is a lamp. A lamp is a furniture (piece). A car headlight is *not* a furniture (piece).
- A hammock is a bed. A bed is a furniture (piece). A hammock is *not* a furniture (piece).

Further developments in experimental psychology gave rise to a number of competing theories of concepts, which may be roughly classified into three kinds: *prototype theories*; *exemplar theories*; and *knowledge theories*, or "theory" theories (Murphy, 2002, pp. 41–65).

The differences between them notwithstanding, all these accounts of concepts share the basic tenets of the modern critique of the classical theory. They reject the received view on instantiation if we interpret this relation as that between particular objects and concepts. Consequently, we need a new account of instantiation, provided that we want to employ in philosophy or elsewhere the tools that are fine-tuned with our conceptual apparatus. Obviously, different theories of concepts may lead to different views on instantiation, although the latter need not follow the former in every detail. For the purpose of this paper, I tested out the theory propounded by Barsalou (1993). In contradistinction to other approaches, Barsalou attempts to develop a kind of common conceptual language in which different theories of concepts may be rendered, rather than a yet-another model of concepts. Apparently, he seems to believe that the similarities among these accounts are more substantial than what meets the eye, arguing that despite all their differences, there exists a distinct abstract structure in which they can be expressed and whose capabilities are commensurable to the complexity of human knowledge (pp. 98–99). This lingua franca to speak about human concepts hinges on the notion of *frame*.

Frames for Concepts

A *frame* is a data structure composed of four types of elements: attributes; attributes' values; structural invariants among attributes; and constraints on attributes' values.[3] The singular function of frames is to define or characterize concepts. Consider, for example, the concept of *watch* as (partially) described by the frame depicted in figure 1. The frame represents this concept by means of three attributes: movement mechanism, display, and case. The movement mechanism represents the physical principle of the watch's operation, and our frame assigns it two values: mechanical and electronic. The display attribute characterizes the way in which normal watches provide time. The third attribute, case, represents the kind of substance the case is made of. The frame in question also contains a *structural invariant*, which is represented by the solid line tagged "contains." The role of this invariant is to integrate the case attribute with the movement mechanism. Finally, the frame also contains a *value constraint*—indicated by the untagged dotted line at bottom left—to the effect that mechanical movement usually simultaneously occurs with the analog display. This last element of the frame is distinctive of Barsalou's account, as this constraint does not mean that each mechanical watch has an analog display, but only that many of them do. In general, the notions of struc-

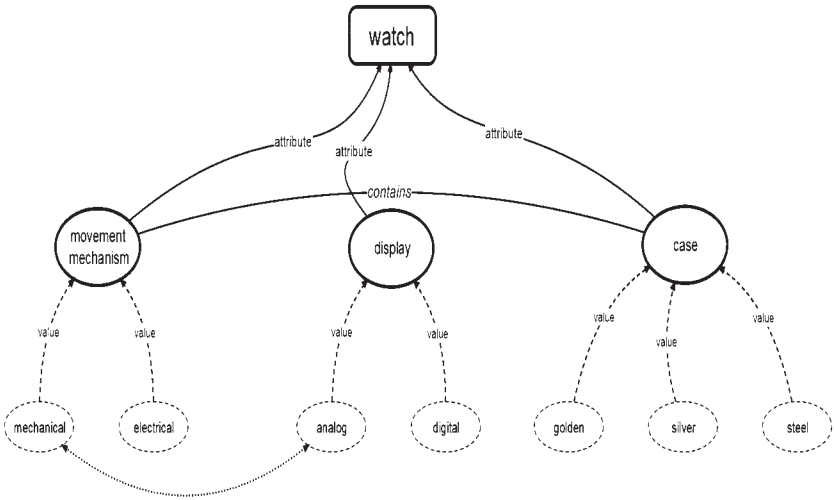

Figure 1. A frame for the concept *watch*.

tural invariant and value constraint cannot be interpreted in terms of the universal quantifier.

Given the context of the present research, three distinctive features of Barsalou's frames need to be highlighted: extendibility, flexibility, and ungroundedness. Let me start with *extendibility*. Since frames represent concepts, and both attributes and their values are concepts, there may exist, therefore, frames that represent other frames' attributes and their values. For example, the attribute "companion" in the frame "vacation" may be represented by another frame in which it has its own attributes—for example, age, relation, preferred activities, and so on. Moreover, a structural invariant within one frame can be extended in another frame; there are frames for structural invariants and value constraints. Barsalou (1993) provides us with the example of the "parthood relation," which is a structural invariant in a number of frames. Following Winston, Chafin, and Herrmann (1987), he claims that parthood can be represented by a frame with four attributes: functionality, separability, homeomeronymy, and spatiotemporal extent. The other feature of Barsalou's (1993) conception is the *flexibility* of concepts:

> Consider the word "newspaper" and note which of its features come to mind. Now consider the word "newspaper" in the context of building a fire. Whereas the feature *flammable* probably didn't come to mind when you consider "newspaper" in isolation, it probably did when you considered it in the context of building a fire. Many researchers have implemented such manipulations in experiments and observed large effects on verification time. (p. 31)

Generally speaking, the flexibility of a concept consists in the variability of its content and structure with respect to different individuals who entertain the concept and with respect to different occasions (contexts) in which it is employed. I propound that one may capture this phenomenon by means of what I call the "main frame and its variants." According to the explanations given in Barsalou (1992, pp. 33–34), we store in our long-term memory a sort of maximal frame for each concept—the *main frame*. This frame is constituted by the most comprehensive set of attributes for the concept.[4] Barsalou (1993) reports the results of an experiment that supports the claim that the content of the main frame tends to be highly stable for individuals over extended periods of time. The main frame is accessed on different occasions by means of various subsets of this set, and each such subset may be represented by a frame. Barsalou holds that each such subset may give rise to a new concept and its frame, which I call a "variant" of the main frame. For instance, if we make a (grossly oversimplified) assumption to the effect that the frame in figure 1 is the main frame for the concept of *watch*, then the frames in figures 2 and 3 may be found among its variants. On the other hand, if you believe that the movement mechanism is an indispensable part of any watch, then the frame in figure 4 does not belong to the set of frames that characterize this concept.

Therefore, a concept may be associated with a number of frames due to its flexibility, which reflects the multifarious contexts in which it is employed. If one construes frames in terms of graphs or some other set-theoretical constructs, one may then introduce the notion of *frame inclusion*. A frame f_1 will be said to *include* a frame f_2 if

- every attribute of f_2 is an attribute of f_1;
- every value (of an attribute) of f_2 is a value (of the same attribute) of f_1;
- every structural invariant of f_2 is a structural invariant of f_1; and
- every value constraint of f_2 is a value constraint of f_1.

Then the frame in figure 1 includes the frames in figures 2–4, but the frame in figure 2 does not include the frame in figure 3, and vice versa. In general, a main frame includes each of its variants.

A set of frames, including their variants and extensions, may give rise to a more complex structure, a *system of frames*, whose role is to represent a body of human knowledge. Barsalou (1992) repeatedly claims that within any such system, each concept is represented by, at most, one frame—"the one-entity one-frame principle," which is to be interpreted here as the claim that each concept has exactly one main frame (and possibly numerous variants thereof). The last characteristic aspect of frames concerns their *ungroundedness*:

> Human conceptual knowledge appears to be frames all the way down. Frames are composed of attributes, structural invariants, and con-

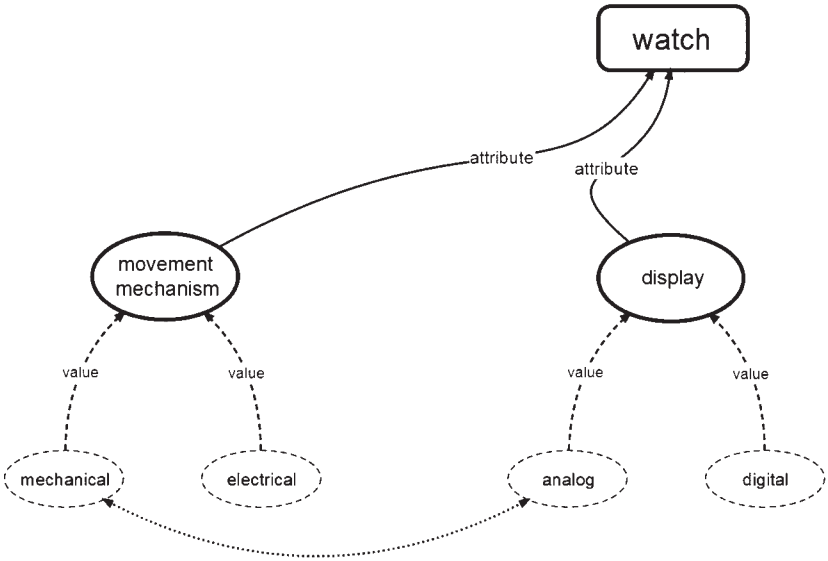

Figure 2. A variant of the main frame for the concept *watch*.

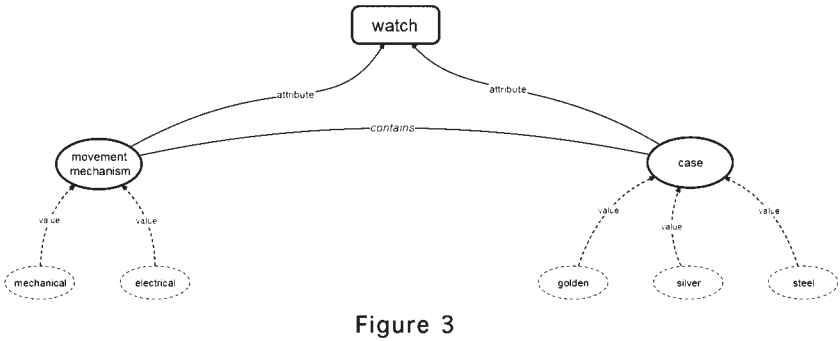

Figure 3. Another variant of the main frame for the concept *watch*.

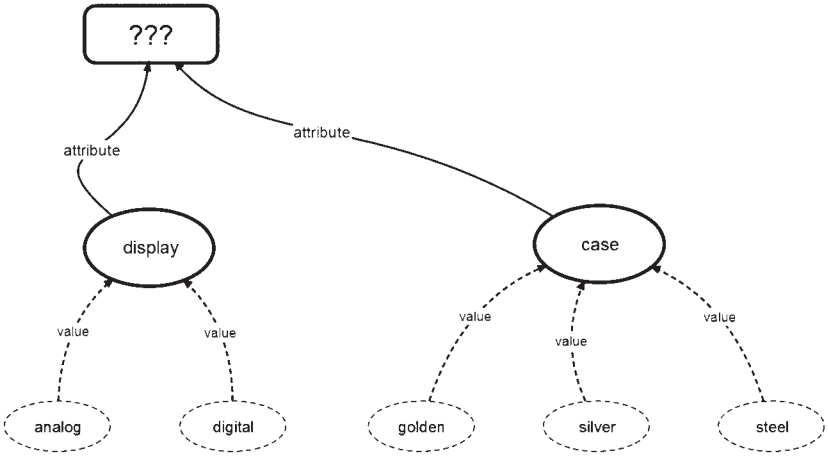

Figure 4. A frame outside the concept *watch*.

> straints, which in turn are represented by frames themselves. . . . For any attribute, structural invariant, or constraint, people can always construct further attributes, structural invariants, and constraints that capture variability across instances. . . . What was once a simple, unitary primitive becomes analyzed and elaborated, such that it becomes a complex concept. For any representational content . . . people can always note a new source of variability across instances, and add further frame structure to capture it. . . . As a result, primitives that serve as simple, elementary building blocks no longer exist. Note that this is not an ontological claim about the structure of the physical world but is instead a psychological conjecture about how people represent it. (pp. 40–42)

Consider one of Barsalou and Hale's (1991) examples of how such analysis may begin: "People's knowledge of house contains an attribute for 'location.' In turn, an attribute of a house's location is its convenience. In turn, an attribute of convenience (for a house's location) is its 'proximity to employment.' In turn, an attribute of proximity to employment is 'driving duration.' In turn, an attribute of driving duration is 'traffic conditions'" (p. 133). Each frame component may have a probabilistic nature so we may assign it a certain weight (a real number from the range [0, 1]), which represents its relevance for a given frame, because some concepts may require such probabilistic frames. Unfortunately, Barsalou did not provide a more rigorous description of frames, although some preliminary attempts to formalize them were undertaken—for example, Petersen (2007) and Urbaniak (2010).

A Frame-based Perspective on Instantiation

What are the implications of the theory of frames for the notion of instantiation? First, the relation between a single particular object and an abstract class or concept is not as simple as the set-theoretical membership. Given the context of the frame theory, it is construed here as a compound that might be "disassembled" into two components: the relation between a single object and a single frame; and the relation between a single frame and a set of frames. Thus, when a particular object instantiates an abstract class or concept, this means that it falls under a frame, and that this frame belongs to a set of frames that represents this class or concept.

The first of these relations does not relate particular objects with "flat" sets, but it relates them with complex systems or structures, which can be approximated as directed acyclic graphs (Petersen, 2007). This implies that an object x *falls under* a frame f when: for each attribute a of frame f, x has a property that is a value of a (within f); and if f has a value constraint c that relates values v_1 and v_2, then x has v_1 if and only if x has v_2. The second relation amounts to the set-theoretical membership—that is, $\in$—between a frame and a set of frames. (Note that the concatenation of these two relations implies that the relation of instantiation is systematically ambiguous; it may happen that two objects falling under one concept have no properties in common because they fall under two frames whose list of attributes are disjoint. In other words, that x_1 instantiates class/concept c may mean something different than that x_2 instantiates class/concept c.)

Second, it follows from this definition that if one frame includes another, then any object that instantiates the former frame instantiates also the latter. In particular, if an object instantiates the main frame for a concept, then it instantiates each frame for this concept but not vice versa.

Third, any component of a frame may be extended in its own frames so that each frame is involved in a system of frames. In principle, this extendibility of the frames' components may have its impact on the relation of instantiation—or, more precisely, on its first subrelation. Thus, one may modify its definition as follows. An object x *falls under* a frame f when: for each attribute a of frame f, x falls under a frame f' that characterizes a value of a (within f); and if f has a value constraint c that relates values v_1 and v_2, then x falls under a frame f_1 for v_1 if and only if x falls under a frame f_2 for v_2.

However, this change does not blend well with the aforementioned principle of Barsalou's theory that "human conceptual knowledge appears to be frames all the way down" (1992, p. 40). Having both of them, we would get a kind of vicious *regressus in infinitum*: x falls under f only if x falls under frame f_1 that characterizes one of f's attributes' values only if x falls under frame f_2 that characterizes one of f_1's attributes' values only if . . . In order to stop this regress, one needs either to reject the principle in question, admitting that some components are not further characterized

by frames, or to admit that in (at least) some cases, the fact that an object exhibits a value (from a certain frame) does not amount to this object's falling under another frame.

Fourth, even if we focus only on the deterministic (that is, nonprobabilistic) frames, the relation of instantiation need not have to be semantically crisp and may allow for fuzziness and different grades of typicality. Suppose that there are three individuals, *x*, *y*, and *z*, and three frames, f_1, f_2, f_3, for concept *c*, such that f_1 includes f_2 and f_3. If *x* falls under frame f_1, y falls under frame f_2, z falls under frame f_3, but neither *y* nor *z* falls under f_1, then one can say that *x* is a more typical instance of *c* than *y* and *z*, or that the degree of *x*'s instantiating *c* is greater than the degree for *y* or *z*. Moreover, although both *y* and *z* are instances of *c*, their membership is somehow different because they fall under different frames for *c*, so the fact that *y* is an instance of *c* means something different than the fact that *z* is an instance of *c*.

In addition, the theory of frames defines a new construal of the subsumption relation. Suppose that there are two categories, c_1 and c_2, each defined by a respective set of frames, and we want to find out whether one subsumes the other. Instead of the extensional definition offered by the received view, we may now say that category c_1 *subsumes* category c_2 if for frame f_2 for c_2 there exists a frame f_1 for c_1, such that f_2 includes f_1. Then, given the above definition of instantiation, it follows that each object that falls under c_2 also falls under c_1, but it does not follow that if each object that falls under c_2 also falls under c_1, then c_1 subsumes c_2. As a result, this relation of subsumption need not be transitive—as Hampton's (1982) experiments attest. If the frames in question are sufficiently complex, it may happen that category c_1 has a frame f_1 that includes a frame f_2 for category c_2, category c_2 has a frame f_2' ($f_2' \neq f_2$) that includes a frame f_3 for category c_2, but no frame for category c_1 includes a frame for category c_3.[5] Then, due to the definition of subsumption above, c_2 subsumes c_1, c_3 subsumes c_2, but c_3 does not subsume c_1.

In a sense, this notion of subsumption is sensitive to a selection of frames, so perhaps we should think about it as relative to frames rather than as subsumption *simpliciter*. For example, the notion of *chair* subsumes the notion of *sedan chair* relative to the set of frames that focuses on human behavior, while the notion of *furniture* subsumes the notion of *chair* relative to the set of frames that also takes into account the spatial characteristics and the aesthetic values of the artifacts we use.

Finally, note that the received view on instantiation is, in fact, a borderline case of this new perspective. If a concept has only one (deterministic) frame, then the relation of instantiation has the characteristics we know from the classical theory of concepts. Consider, for instance, a kind of degenerate frame for the notion of *triangle* that has only two attributes: being a polygon, having three sides. If this notion is defined only by this frame, then it is described by the classical theory of concepts:

- Something is a triangle if and only if it is a polygon and has three sides.
- Any object either is a triangle or is not and there are no in-between cases.
- Any triangle is a triangle in the same sense and to the same degree; in other words, "trianglehood" does not come in degrees.

In general, the set of necessary and sufficient conditions that defines a concept according to the classical theory can be translated to a frame that describes this concept.

In what follows, I will attempt to show a possible application of this new perspective on instantiation in LIS. Namely, I will elaborate on the distinction between classification and categorization and the possibility of coordination thereof.

Classification versus Categorization

Jacob (2004) argues that classification and categorization are essentially disparate operations in LIS—although, because they share some common superficial features, they tend to be easily confused.[6] To flesh out this substantial difference, he compares them with respect to the following six aspects:

- Process: *categorization* is claimed to be unsystematic, creative, and responsive to individual similarity assessments based on immediate context; *classification* is the systematic analysis of necessary and jointly sufficient characteristics that define each class.
- Boundaries: *categorization* draws fuzzy boundaries around categories; *classification* aims to establish fixed boundaries for classes.
- Membership (that is, instantiation): whether an object belongs to a *category* is fuzzy and flexible; whether an object belongs to a *class* is fixed and rigorous.
- Criteria of membership: *categorization* is based on context-dependent criteria; *classification* is based on criteria that do not depend on context.
- Typicality: one instance of a *category* may be more or less typical than another instance; all instances of one *class* are on a par—they are typical to this class to the same degree.
- Structure: *categorization* tends to produce clusters of entities rather than rigorous structures; *classification* is about hierarchical systems of classes whose structures are based on clear principles (pp. 527–531).

The last aspect summarizes, in a sense, the main differences between categorization and classification, so let me quote Jacob's description *in extenso*:

> A classification system is generally a hierarchical structure of well-defined, mutually exclusive, and nonoverlapping classes nested in a series of superordinate-subordinate or genus-species relation-

> ships. . . . For example, because an entity either is or is not a member of a particular class in a system of classification, it provides for determination of class membership as a relatively simple pattern-matching or pattern-completing activity. At a more complex level, the structure of the classification system establishes information-bearing relationships between classes: vertical relationships between superordinate and subordinate classes that are subject to the mechanism of inheritance . . .; and lateral relationships between coordinate classes that occur at the same level in the hierarchy and, when taken together, constitute the immediately superordinate class within which they are nested. . . . In contrast, the structure of a categorization system consists of variable clusters of entities that may or may not be organized in a hierarchical structure. Because categories are not constrained by a requirement for mutual exclusivity, membership in one category does not prohibit membership in any other category. . . . The potentially transitory and overlapping nature of categories provides that any relationships established between categories are themselves mutable. (pp. 530–531)

I will now investigate whether and to what extent the frame-based perspective on instantiation may bridge the gap between categorization and classification. Consider the following scenario. Suppose that we are given three categories, c_1, c_2, c_3, within a context of categorization, and three classes, C_1, C_2, C_3, within a context of classification. The three classes form a simple hierarchy: C_1 and C_2 partition C_3; that is, each instance of C_3 belongs either to C_1 or C_2, and C_1 is disjoint from C_2. The three categories exhibit the average features of human concepts: fuzzy boundaries, typicality, flexibility, and so on; on the other hand, the three classes are, in fact, sets. Finally, there is an assumption that the set of categories and the system of classes are intended to grasp the same aspects of a given domain, so there is a need to coordinate them.

The theory of frames may provide a framework in which these two different ways of representation can be harmonized so that a piece of information rendered in one of them can be translated to the other. To this end, for each class, we need to find its frame. Since classes resemble concepts as construed in the classical theory of concepts, each class might be described by exactly one frame—the *class frame*. Incidentally, note that since C_3 subsumes C_1 and C_2, the frame for the former needs to be included in the class frames for the latter classes. Similarly, for each category, we need to find its frames—*category frames*—which, if the category in question is indeed nonclassical, will be numerous. If the aforementioned assumption is satisfied—that is, if the set of categories and the system of classes indeed represent the same aspects of one common domain—then we should be able to couple categories with classes in such a way that for each couple, the class frame (the frame for the class in the couple) is among the category frames (the frame for the category in the couple).

This condition guarantees a rather strong correspondence between the two means of representation. Having this kind of correspondence, we

would be in a position to detect inconsistency between any two instances of classification and categorization. Suppose that we coupled c_1 and C_1 (in the aforementioned sense) because it happens that the class frame for C_1 is the main frame for c_1. Then the following two claims are inconsistent: x instantiates C_1, and x does not instantiate c_1. The reason is that if x instantiates C_1, then it also instantiates every frame included in the class frame for C_1—in particular, all frames for c_1. So, instantiating the class entails instantiating the category. On the other hand, x may not instantiate C_1 but still does instantiate c_1—possible when instantiating the latter category is less demanding than instantiating the former class. Therefore, although x exhibits *some* features required for its being a C_1 and for that very reason is an instance of category c_1, x does not exhibit all of them and for that very reason fails to instantiate class C_1.

But the assumption on the correspondence between a system of classes and a set of categories may be satisfied also under a more relaxed condition. Suppose that we are able to couple classes with categories in the following sense: for each couple, the class frame includes one of the category frames or a category frame includes the class frame. Then the relationship between these two ways of representation appears to be much weaker than in the previous case, but they are not altogether incompatible.

We could also handle the asymmetric cases of the classification/categorization compatibility, where we are given either a system of classes or a system of categories. Suppose that we are confronted with a set of categories and, for one reason or another, we need to define the corresponding system of classes. Then, once we know the set of frames for a category, we will be in a position to pick up one of those frames—the main frame seeming to be the most suitable—to be the class frame for the class that corresponds to the category. Moreover, once we know a set of frames for each category, we can attempt to arrange those categories by the relation of subsumption. For example, the definition given above implies that if one frame includes another, then any category characterized by the latter frame subsumes a category characterized by the former. Thus, if a set of categories can be characterized by means of frames, we may establish a certain order or regularity between those categories. If our frame description is adequate, this pattern is discovered rather than stipulated. And the system of categories that emerges thereby is similar to classification systems though not equivalent because the relation of subsumption based on frames is of a rather peculiar type, as I argued earlier. On the other hand, if it were given a system of classes and we want to define the corresponding system of categories, then for each class, we can construe its class frame as the main frame for the corresponding category, which delimits the boundaries of the variety for the category in question. Namely, one can pick up a number of frames that are included in the main frame, and the set of all such frames, including the main one, will define the

corresponding category. Of course, this procedure will not define the unique category for a given class; in fact, it will provide a set of categories, where each category is defined by a set of frames that are included in the class frame. But this should not be surprising: one can render precise a fuzzy concept in a unique way, but usually one can make fuzzy a precise concept in more than one way.

These thought experiments show, in my opinion, how the possibility of characterizing both classes and categories in terms of Barsalou's frames may bridge the gap between classification and categorization. We may, thereby, coordinate the two ways of representation in a systematic and principled manner.

Conclusion

Although we often make claims to the effect that a certain particular object exhibits some general characteristics or property, the actual content and implications of such claims sometimes remain conceptually opaque. The standard view on the relation of instantiation seems to be oversimplified to the point of being naïve, but neither philosophy nor psychology have developed a single alternative theory to explain the sufficient number of phenomena in our use of concepts. This lack of insight is particularly troublesome in LIS, where classification and categorization are among the most elementary mental activities. Still, studying the existing theories of concepts may shed some light on the problems encountered therein. In this paper, I have tried to outline a new perspective on instantiation inspired by the theory of frames developed by Barsalou. Although my outline of this perspective is intrinsically vague, it aims to exemplify how psychology may influence LIS. If this perspective is congruent with the current developments in psychology as I propound, its validity needs to be established by further, more empirical research.

Acknowledgment

The research reported in this paper was supported by grant 2011/01/B/HS1/01927 funded by the National Science Centre (Poland).

Notes

1. The terminology in question may be confusing. For instance, in analytical philosophy, there is a tendency to speak about "properties" when referring to the "abstract" end of the instantation relation (see Oliver, 1996).
2. Let me emphasize the fact that, strictly speaking, the formal semantics, which these technologies presuppose, implies the identification thesis that *abstract categories are sets of particulars.*
3. As a matter of fact, Barsalou speaks about constraints in general and draws two orthogonal partitions thereby: *attribute* constraints versus *value* constraints; and *contextual* constraints versus *optimizations.* Therefore, my exposition simplifies Barsalou's account to a certain degree. See also Garbacz (2013).
4. Interestingly enough, quoting Goodman (1955), Barsalou maintains that the latter set can be infinite.

5. This possibility holds in the following example: frame f_1 has three attributes, a_1, a_2, a_3; frame f_2 has two of them—say a_1 and a_2—but frame f_2' has a_2 and a_4; and frame f_3 has a_4.
6. For this reason, in this section I will differentiate between *classes* and *categories*.

References

Allemang, D., & Hendler, J. (2008). *Semantic web for the working ontologist: Effective modeling in RDFS and OWL*. Burlington, MA: Morgan Kaufmann.

Anderson, M. L. (2003). Embodied cognition: A field guide. *Artificial Intelligence, 149*(1), 91–130.

Barsalou, L. W. (1992). Concepts and conceptual fields. In A. Lehrer & E. F. Kittay (Eds.), *Frames, fields, and contrasts: New essays in semantic and lexical organization* (pp. 21–74). Hillsdale, NJ: Lawrence Erlbaum.

Barsalou, L. W. (1993). Flexibility, structure, and linguistic vagary in concepts: Manifestations of a compositional system of perceptual symbols. In A. F. Collins, S. E. Gathercole, M. A. Conway, & P. E. Morris (Eds.), *Theories of memory* (pp. 29–101). Hillsdale, NJ: Lawrence Erlbaum.

Barsalou, L. W., & Hale, C. R. (1991). Components of conceptual representations: From feature lists to complex frames. In I. van Mechelen, J. Hampton, R. Michalski, & P. Theuns (Eds.), *Categories and concepts: Theoretical views and inductive data analysis* (pp. 97–144). San Diego, CA: Academic Press.

Garbacz, P. (2013). Artefact and family resemblance. *Review of Philosophy and Psychology, 4*(3), 419–447.

Goodman, N. (1955). *Fact, fiction, and forecast*. Cambridge, MA: Harvard University Press.

Hampton, J. A. (1982). A demonstration of intransitivity in natural categories. *Cognition, 12*(2), 151–164.

Jacob, E. K. (2004). Classification and categorization: A difference that makes a difference. *Library Trends, 52*(3), 515–540.

Murphy, G. L. (2002). *The big book of concepts*. Cambridge, MA: MIT Press.

Oliver, A. (1996). The metaphysics of properties. *Mind, 105*(417), 1–80.

Petersen, W. (2007). Formal representation of frames. *Baltic International Yearbook of Cognition, Logic and Communication, 2*, 151–170.

Rodriguez-Pereyra, G. (2000). What is the problem of universals? *Mind, 109*(434), 255–273.

Rosch, E., & Mervis, C. B. (1975). Family resemblances: Studies in the internal structure of categories. *Cognitive Psychology, 7*, 573–605.

Smiraglia, R. P. (2005). Instantiation: Toward a theory. *Data, information, and knowledge in a networked world*. Retrieved August 31, 2013, from http://www.cais-acsi.ca/proceedings/2005/smiraglia_2005.pdf

Tarski, A. (1983). The concept of truth in the languages of the deductive sciences. In J. Corcoran (Ed.), *Logic, semantics, metamathematics: Papers from 1923 to 1938* (pp. 152–278). Indianapolis, IN: Hackett. (Original work published 1933)

Urbaniak, R. (2010). Capturing dynamic conceptual frames. *Logic Journal of the IGPL, 18*(3), 430–455.

Winston, M. E., Chafin, R., & Herrmann, D. (1987). A taxonomy of part-whole relations. *Cognitive Science, 11*(4), 417–444.

Pawel Garbacz is an associate professor in the Department of Philosophy at John Paul II Catholic University of Lublin in Poland, where he teaches formal logic and set theory. His research focuses on the interdisciplinary problems in artificial intelligence, in particular on those topics that combine the rigor of formal logic with philosophical insights. He has been a visiting professor at Hoger Instituut voor Wijsbegeerte; Katholieke Universiteit Leuven; Laboratory for Applied Ontology, Institute of Cognitive Sciences and Technologies, Trento, Italy; and Institute of Scientific and Industrial Research, Osaka University.