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Cross-sortal Predication and Polysemy

Petr Šimon, Chu-Ren Huang

Department of Chinese and Bilingual Studies
Hong Kong Polytechnic University
Kowloon, Hong Kong
{petr.simon,churenhuang}@gmail.com

Abstract This paper develops new treatment of the problem of cross-sortal predication and co-predication in particular. We argue that the solution to these predicate-argument sort mismatches can be solved by a more flexible treatment of polysemy based on the notion of dependent type and dynamic construction of meaning.

Keywords: lexical semantics, formal semantics, type theory, ontology, generative lexicon

1 Introduction

Cross-sortal predication is natural language phenomenon, which has not been paid much attention to, perhaps more in lexicographic circles where it serves as a sense disambiguating tool (Cruse, 2000b). This phenomenon nevertheless plays an important role in the development of formal account of lexical semantics and could be seen as one of fundamental problems whose solution could lead to better understanding of semantic well-formedness of natural language expressions. As argued in (Borschev and Partee, 2001), the biggest challenge for formal lexical semantics is the establishment of a relation between types and sorts as well as a formulation of a theory that would account for the contribution of sorts to the semantic well-formedness of expressions.

We suggest that cross-sortal predication plays such an important role in the development of formal lexical semantics for three reasons. Firstly because it involves the problem of compositionality and in particular the conditions under which certain predicate can be applied to certain argument even in cases when the sort of the argument mismatches the domain of the predicate. Secondly, it introduces a problem of identity of an argument in composition of predicates. And thirdly, cross-sortal predication seems to be quite common even cross-linguistically and thus calls for a general and flexible solution.

1.1 Types and sorts

What we call here *sort* is usually referred to as type, lexical type or ontological type, usually without any detailed specification as to what these might be and especially how are they related to the classical logical types. Typically, inheritance among sorts and few other relations such as meronymy are assumed. We will, however, draw a line between sorts and types, at least within classical formal semantics.

We use the term *sort* for everything that would be typically recognised as being an entity (in classical logic: Montagovian type e or Churchian ι). Informally, sorts would be viewed as elements of the set of entities, organised in a directed graph, which can be viewed as a hierarchical structure along the inheritance path.

For the discussion within classical formal semantics, we reserve the term *type* to refer to truth values, o, and to entities in general, ι. Other ground types might be also added, such as times τ or possible worlds ω and naturally new types can be constructed from the basic ones. We might, for example, find useful the event type ϵ, which we could construct as functional type from the type of entities ι and times τ, reflecting the intuition that events are mapping between entities with time factor involved[1].

Type of variables, functions and constants and sort of variables and constants will be specified by superscript; sorts are designated by upper case Latin alphabet, types in lower case Greek alphabet: a^A (a is of sort A), f^{oA} (f is of type oA, i.e. mapping from A into o[2]), g^{ooo} (g is of type ooo, i.e. type of logical

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[1] The are well-known correspondences between nominal and verbal expressions such as mass-count/aspect (Bach, 1986), space/time (Lambalgen and Hamm, 2005).

[2] Following (Duží *et al.*, 2010, 44).

operators). Type construction rules are also applicable to sorts, e.g. if o is a type, so is oo and analogically, if A is a sort, AA is a type. Since sorts are conceived as specialised subtypes of ι , the type of entities, the classical type $o\iota$ is a superset of types oS, where S is any sort.

1.2 Cross-sortal predication

We recognise two different kinds of cross-sortal predication:

(1) *Cross-sortal predication* is a meaningful construction in which a predicate with domain of sort A is applied to an argument of sort B, e.g. $(\lambda x^{A}.f^{oA}x)a^{B}$ or $(\lambda x^{A}.(f^{oA}x \wedge g^{oA}x))a^{B}$.

(2) *Co-predication* is a meaningful construction in which two predicates, each of incompatible sort, are applied to single argument, e.g. $(\lambda x^{oA}\lambda y^{oB}.(f^{oA}x \wedge g^{oB}y))a^{(A,B)}$, where (A, B) signifies that the argument is capable of *providing* both sorts A and B. We will refer to arguments that allow co-predication as *complex arguments.*

We use the term *cross-sortal predication* in general sense to refer to both the general phenomenon of sorts crossing and in narrow sense to indicate a single predication where the sort of the argument is coerced into different sort, the original sort being discarded. This is for example the case of so called *grinding*, a transformation of countable nouns into mass nouns, e.g. *chicken:* 'animal'→'meat'. There can be one or more predicates, but all the predicates have the same domain. In the following, we will concentrate mostly on co-predication, but we will use a contrast between acceptable and unacceptable cases of cross-sortal predication to demonstrate a condition that introduces a useful restriction on possible constructions, a restriction that has not yet been noted in the literature.

Co-predication is conceived as a subtype of cross-sortal predication (in general sense). Due to a syntactic requirement for an identity of an argument of composed predicates, e.g. *carry and master a textbook*, the argument is necessarily thought of as complex or structured. Each of the two predicates is then assumed to be predicating upon a different sense of *textbook.* Pustejovsky (1995), in order to account for these complex arguments, proposes a notion of a *dot object*, an object that consists of several, usually two, incompatible sorts. The original proposal suggests that dot object is a product of the two component sorts. The relation between the two sorts is recorded separately in the lexical entry. Interestingly, most of the examples of dot objects are composed of only two different sorts (e.g. *book*, *lunch*, *tuna*, *lecture*) and at most of three (e.g. *newspaper*, *school, class, city*). Even more interesting seems the fact that there are no examples of co-predication which would involve three sorts of a single argument. In fact, some of the dot objects[3], such as *newspaper*, contain *co-predicatively incompatible* sorts for which there does not seem to be an acceptable co-predication example, e.g. *newspaper* as an 'organisation' and as an 'informational content'.

The term co-predication itself has been coined in the context of a theory of Generative Lexicon (Pustejovsky, 1995). The subsequent research on a type-theoretical enhancement of the theory[4] has not offered much more insight into the nature of arguments that allow two incompatible predicates to apply to them. The reason for this lies in the tacit assumption that the co-predication process does not involve coercion and that the two sorts that the argument is composed of are equal in significance, or in other words, that the two sorts are understood as a pair of objects, similar to product, creating another object.

1.3 Types of co-predication

Words that allow co-predication seem to be limited to a small number of semantic classes of nouns. Cruse (2000a) offers to our knowledge the best overview of phenomena related to these words and introduces several tests that can be used to identify them.

Consider the following examples of co-predication:

(3) They published a book.

(4) It was a delicious and leisurely lunch.

(5) The police burnt the controversial book.

(6) The book is heavy, but interesting.

In these (and other) examples, four general patterns can be observed (for English):

(a) *V-N*: both senses might be activated by the predicate, e.g. *publish a book.*

[3] For a list of examples see e.g. (Rumshisky *et al.*, 2007).

[4] See in particular (Pustejovsky, 1998; Asher and Pustejovsky, 2000; Pustejovsky, 2000; Pustejovsky, 2001; Pustejovsky, 2005; Pustejovsky, 2006; Pustejovsky and Jezek, 2008).

(b) V_1-V_2-*N*: each of the verbs selects different sense, e.g. *open and pour wine.*

(c) *V-A-N*: the verb and the adjective each select different sense, e.g. *burn a controversial book.*

(d) A_1-A_2-*N*: each of the adjectives modifies specific sense, viz. example (4).

There is also a group of verbs that refer to linguistic and other semiotic activities, the principal representative of which in English would be *to read*. The rest would comprise: *write*, *listen/hear* (*music*, *lecture*), *watch* (*TV*), *see/look at* (*painting*), *talk*, etc. These verbs seem to be without exception susceptible to co-predication since each of the activities involves some form of physical transport of information. All such words seem to be therefore ontologically predisposed to act as predicates that have structured meaning and involve concepts of different sorts.

All the current approaches to co-predication are working with a notion of a single argument whose sort is either coerced into another sort or which is itself a product of two different sorts, which are "somehow fused into a single conceptual unit" (Cruse, 2000b, p. 116). As a result, the current approaches implicitly work with a notion that complex arguments represent special sorts containing two component sorts. This conception is nevertheless rather unintuitive, since it seems impossible to conceive something that would be e.g. a 'physical object' and an 'information' at the same time.

1.4 Argument identity

We argue that the assumed identity of an argument in co-predication is merely a syntactic phenomenon. Semantically (and ontologically) there are two different arguments. From this point of view, what we called *complex argument* would perhaps better be referred to as *argument with two mutually dependent referents*. We agree with (Cruse, 2000a) that it is doubtful that there is a unique ontological entity, a unique sort, that could be called 'book' or 'lunch'. Let us demonstrate the intuition behind this view on the following examples:

(7) It's a heavy, but interesting book.

(8) The tuna put up a good fight and it was delicious.

There is no entity referred to by the word *book* that could be *heavy* and *interesting*. But since the entity that can be heavy contains another entity that can be interesting and more importantly, that the heavy entity referred to as a *book* would cease to be a *book* if it did not contain another entity that can be interesting, co-predication is possible; the two entities coexist and by mutual dependence create two new entities. One is 'book-p', a physical sense of a *book*, containing 'book-i', an informational sense of book, such as a novel, which is contained in 'book-p'. Intuitively, individuals we talk and think about, seem to have only one "substance"; they belong to a certain sort. This is expressed in the notion of dependent sorts: 'book-p' is a "'physical object' (with additional properties) such that 'contains' some 'informational object' (with additional properties)" and analogically for 'book-i'.

The notion of dependent sort is inspired by the notion of *dependent type* in the constructive type theory (CTT)(Ranta, 1995; Jacobs, 1998), which is itself based on the notion of *such that* from (Martin-Löf, 1984, p. 28). We recognise ground sorts A, B, but there are no functional sorts. Here we want to argue for dependent sorts, which express the notion of "x of type A such that there is y of type B for which relation $f(x, y)$ holds". Thus, dependent sort is not a set theoretic object. Rather, it is a structured object. We would argue that not only the small class of nouns studied here can be approached via structures like these, but all words.

On the other hand, *tuna* starts to refer to 'meat' only when the 'animal' is killed and chopped up. The word *tuna* can however occur in seemingly co-predicative context, such as example (8), but only when the two stages referred to by the word *tuna* are separated by different time frames.

We suggest that the motivation for previous approaches to cross-sortal predication introduced bellow was based on a *fallacy of misplaced individuation*. This motivation is rather pertinently expressed in (Cooper, 2007): "The conjunction *be delicious* and *take forever* needs to require that its subject is both food and an event." In other words, the strings and categories these words represent that appear in syntactic constructions are assumed to be injections into a set of types.

We suggest that complex arguments can be treated basically as other polysemies, with the exception that their referents are not simple sorts, but rather mutually dependent ones.

2 Previous work

Recently, two notable proposals have been made by Asher (2008) and Bassac *et al.* (2010)[5].

[5] First published online in 2009.

Asher (2008) suggests an improved approach to the original set-theoretic theory proposed by the Generative Lexicon theory (GLT) by reformulating the notion of predication as "an attribution of a property to an object under a certain conceptualisation", which is to be understood as "an object combined with some property". The "structure" of a complex argument is informally specified by: "inhabitants of complex types thus would be simple objects but with different aspects; these aspects can accept properties that when simply predicated of the simple object would be incompatible". Asher correctly refutes the notion dot objects as pairs and suggests that e.g. *lunch* is either wholly an 'event' or wholly a 'food' and proposes that the structure of complex types could be modelled as a category-theoretical *pullback*. The general approach taken by Asher seems appealing, but the conclusions are rather unintuitive as the theory still seems to predict existence of complex objects such as 'book' or 'lunch'. The solution to the problem of co-predication is provided by a special function O-Elab, which takes two arguments, the complex argument and the sorts of domain of the predicate, and returns the sort that matches the sort of the domain of the predicate and thus works as a projection operator. We can identify with the informal motivation of Asher's approach and argue that it is merely a limitation of the formalism used that forces the notion of complex type with projections to simple sorts, a kind of black box, from which needed sorts can be retrieved on demand.

Bassac *et al.* (2010), critically dismiss (Asher, 2008) and propose to deal with the cross-sortal predication by sort transformations applied either globally by coercing the argument first for all predicates or locally for each predicate specifically. Secondary morphisms, which are provided by the lexicon via records called qualia structure, enable these transformations during evaluation of terms composed of subterms of incompatible sorts. E.g. the term $(\lambda x^S.(small^{oS}x))\,a^S$ formalises an expression *small stone*: the sort of argument and domain of predicate match, evaluation can proceed without obstructions. An expression *wondering, loving smile*, would, however, raise a sort mismatch between the two predicates of sort P, person, and the argument, of sort S, smile, formally

(9) $(\lambda x^P.(and^{ooo}(w^{oP}x)(l^{oP}x)))\,a^S.$

An additional morphism is required in this case. The argument is supplemented by the morphism f^{PS}, which allows coercion of 'smile' into 'person'. This is an example of global transformation, where an argument is transformed for all predicates in the term before evaluation takes place.

To illustrate the local transformation strategy, the authors provide the sentence *Copenhagen is both a seaport and a cosmopolitan capital*. As a 'town' T, *Copenhagen* would be lexically equipped with two additional morphisms, f^{PT} and g^{LT}, transforming *towns* into *people* or *loci*, respectively. For the lack of space, we will omit exposition of the whole evaluation here. It should suffice to say that it rests on the second-order abstraction, which binds type variables in the respective morphisms.

The main problem with the original approach of (Pustejovsky, 1995), which is basically retained by (Bassac *et al.*, 2010), is the lack of rule which would help to choose from the set of the secondary morphisms the morphism appropriate for the interpretation of an expression, this is in our opinion caused by the lack of context handling. Second problem, which the authors explicitly recognise, is the lack of devices that would allow to choose between global and local transformation. The authors point out that some syntactic constructions involving co-predication might be more acceptable than others: *a blue and open door* vs. *the blue door is open* or *heavy and interesting book* vs. *heavy, yet interesting book*.

New formalisation of dot objects is suggested by (Luo, 2010), based on the constructive type theory and the notion of coercive subtyping introduced in (Luo, 1997). This approach, even though elegant and straightforward, nevertheless suggests the same unintuitive result as the theories discussed above, i.e. that there are objects that are somehow both A and B.

Intuitively, there is another problem with the notion of complex argument as a product from which the simple constituent types can be retrieved via projections. Take for example the word *book*: the theories coercing $book^{P\bullet I}$ into either $book^P$ or $book^I$ loose an important aspect of the meaning of *book*, which becomes either a bare 'physical object' or a bare 'information'. In order to talk about meaning of *book*, both components have to be present. We can manipulate with books the same way as we do with some general physical object, we can for example *carry*, *drop* or *throw* them by the virtue of them being subtypes of 'physical object' and we can formalise this neatly in logic or a type theory. But where does the rest of the meaning of *book* go? Objects can be manipulated by casting their type into an appropriate type or, as we want to argue here, by virtue of types that constitute that object. In other words, we need a notion of structured meaning. Objects can be "transformed" or viewed from different perspective without loosing any of their meaning components. We are arguing against casting more complex types into simpler ones and loosing information in the process.

In general, we see the notion of dot object as an abstraction in which the relation of the two component sorts is lost and needs to be appended externally as is the case of the GLT. The results of the above discussed research can be in fact consolidated into a unified theory. Main goal of such theory would be to transparently represent the relation between the two sorts that complex arguments can yield. The notion of dot object, being modeled as a product of two types or sorts, does a poor job, it is too constrained and inflexible. We will outline such theory below.

3 Predication with structured meaning

3.1 Structured meaning

All the current approaches to co-predication work with an object that can yield two incompatible sorts. It appears that it is assumed that there are thus three different objects: the two component sorts A and B and the product sort C. This is a natural conclusion, because an appropriate sort is necessary for the instantiation of individuals that could be referred to by words such as *book* or *lunch*. However, it seems difficult to grasp the concept of an individual that would be both 'physical object' and 'information' (Cruse, 2000a). In particular, it seems difficult to provide a definition for such an individual or its sort. On the other hand, we have a clear concept of an entity which is "a physical object *such that contains* information" and conversely "an informational object *such that is contained* in a physical object".

One additional argument against the notion of object created as a product of two sorts is the apparent rigidity of the relation (if specified) between the two sorts. This has been observed recently in the generative lexicon literature, see e.g. (Rumshisky *et al.*, 2007; Jezek and Lenci, 2007; Pustejovsky and Jezek, 2008). The phenomenon is referred to as *asymmetry*, since it has been observed that the two component sorts might have different distributional properties such as sense frequency or argument position frequency. Theory employing such a rigid notion of dot object would have difficulties explaining diachronic changes and most likely also cross-linguistic phenomena as is the case with the GLT.

We argue that a more transparent theory of sorts instantiated as an ontology is needed. In (Dapoigny and Barlatier, 2009a; Dapoigny and Barlatier, 2009b), the authors suggest formalisation of ontology based on dependent type theory in order to solve problems inherent in the more common first order logic approaches. They introduce dependent record types, a simple data structure which they use to specify relations between individuals and in particular to improve formalisation of composite relationships (Dapoigny and Barlatier, 2008). A relationship can be expressed as $\Sigma x^A.\Sigma y^B.contains(x, y)$, where the second component (y^B) depends on the first (x^A).

Using this approach, the two alternative senses of the word *book* can be formalised by constructing two dependent types:

(10) 'book-p'$\equiv \Sigma x^P.\Sigma y^I.contains(x, y)$

(11) 'book-i'$\equiv \Sigma x^I.\Sigma y^P.isContained(x, y)$, where $isContained \equiv contains^{-1}$.

Such analysis corresponds to natural language (at least English), reflecting the fact that there does not seem to be a single concept 'book'. As observed in (Cruse, 2000a), the main difference between polysemies such as *bank* and words like *book* is the fact that we don't need to disambiguate the latter, while we always need to disambiguate the former. This fact might be the source of the "feeling" that we are dealing with one individual sort.

This step however does not resolve the fallacy of misplaced individuation. There is obviously only one argument in example (12):

(12) She carried home and mastered that book.

But what is this argument? As discussed above, it does not seem possible to define a single concept that the word *book* could refer to. As claimed in (Asher, 2008), the two predicates *carry* and *master* each acts on a different aspect of a dot object. The dot object thus does seem to have no other function but to act as a container. Apart from co-predication, the apparent unity of the two aspects seems to play an important role also when *book* occurs as an argument of linguistic verbs (viz. 1.3) such as *to read*, which seem to require that an 'information' is contained in a 'physical' medium.

It follows that, for our discussion of linguistic verbs and dot objects, we can actually discharge the predicate whose domain is 'physical object', because both aspects are required by the second predicate such as *read* and concentrate on a simpler pattern *V-N*, viz. example (3). Thus we have one predicate and one argument. We can now ask what is involved in *reading a book* and propose a decomposition of event

structure of the predicate $\lambda x^A.y^R.read(x,y)$, where A, R stands for $Agent$ and $Readable$, respectively. A definition of the verb *to read* arguably requires reference to "visual reception of verbal information", f, and "cognitive reception of information", g:

(13) $\lambda x^A.\lambda y^V.\lambda y^I.g(x,y) \rightarrow f(x,z)$, where A, V, I stands for $Agent$, $Visual$, $Information$, respectively.

The presence of some subsort of 'physical object' seems mandatory for reading and arguably all other information transferring activities. This treatment suggests how sentences such as (14) (due to (Pustejovsky, 2006)):

(14) The passengers read the walls of the subway.

can be interpreted. On a syntactic level, a technique such as Pustejovsky's *dot introduction*, which transforms an argument such as 'wall' into dot object, seems appropriate. But given our previous objections against dot objects and our current subevental analysis of verbs like *read*, we are ready to suggest a different approach to co-predication and predication in general.

3.2 Constructive predication

In this section, we provide an outline of a flexible architecture for predication, in which we suggest to look at predication as a constructive process. Instead of retrieving ready made objects from lexicon, predicates announce their requirements in form of hypotheses, proofs of which are subsequently sought in the graph which encodes the ontology. The search for proof itself is constrained by time and memory. We also make the Open World assumption.

Dependent types in constructive type theory provide a natural way how to handle context as shown e.g. in (Ranta, 1995). When the (potentially) new information is retrieved, it is merged with old knowledge available at the time. During the learning process, due to the time and memory constraints, only a portion of potentially relevant knowledge might be available. The learning process is assumed to be non-monotonic.

The search paths (or computations of proofs) are conceived as *sense* and the value returned (or the proof object itself) as *denotation*. Given that there can be in many cases infinitely many computations of proofs, we assume that given certain criteria (time and memory constraints in general) there are few (perhaps only one) computations that are superior to the rest.

Apart from a "classical proof" a^A, direct (2^N) or indirect ($1 + 1^N$), we also assume a *potential proof*. Given the assumption of sense and denotation, a potential proof is incrementally constructed from the sum of propositions and contexts that are leading to the same proof object, but fail to find it. We can conceive a potential proof as a vertex (or subgraph) in the ontology graph that many propositions and contexts assume, but direct proof of which cannot be reached. We envision two cases:

(a) The vertex (or subgraph) is either not connected to the rest of the graph (or is connected too sparsely, insufficiently).

(b) The vertex (or subgraph) does not exist at all.

The first case is a case of discoveries where existing facts are merely put into the context of previous knowledge, i.e. they are learned.

The second case is a case of invention and it allows us to interpret genuinely novel expressions, which can be at first understood merely as e.g. "something is somehow related to something" or "something is doing something to something", which can be abstracted and identified with "something is happening", which can be either a lie or a fantasy (propositions for which no direct proof can be found) or a (novel) expression that the hearer in question simply does not understand, but nevertheless uses it as a ground (on the basis of belief or trust) on which subsequent claims are interpreted. Completely meaningful, i.e. semantically well-formed, expressions can be constructed and "vacuous" philosophies can be based on them (viz. the famous Wittgenstein's objection in his *Philosophical Investigations*). In other words, we can construct new sorts and objects just because our grammar allows us to do so. We can make sense of complex phenomena by reification and attribution of properties similar to those of more familiar objects.

As a consequence of the above assumptions, we argue for "lexical semantics without lexicon" (Elman, 2009). This also resonates with a doubt about the possibility to create "unitary, sparse, lexical representations and compositional principles (*á la* Pustejovsky)" expressed in (Cruse, 2000a, p. 51). It should be obvious that we are assuming a context dependent notion of meaning.

Now we can explain more explicitly, how we propose to deal with the complex arguments. Given the decomposition of the predicate $\lambda x^A.y^R.read(x,y)$ into (13), the subpredicate f, which represents the

visual subevent of reading, needs to return an appropriate object to the second subpredicate g. Thus, to interpret *read a book* we need a proof of visual event which involves some physical medium and a proof of some information, which has been stored in that physical medium. In the phrase *read a wall*, the 'wall' is not coerced into a dot object, but the predication is interpreted by a search for a proof that would show that walls can be used as information transferring medium. Even though walls are not (proto)*typical* objects that can be read, the phrase can be understood without too much effort. On the other hand, phrases such as *read the bones* or *read the bowels* would require a clear context of shamanism and metaphoric extension, before they could be interpreted, i.e. the proof construction would need to be augmented by auxiliary directions.

As an alternative approach that seems feasible for our purposes is the Transparent Intensional Logic (TIL) (Tichý, 1968; Tichý, 1969; Tichý, 1986; Tichý, 1988) and further developed e.g. in (Tichý, 1994; Materna, 1998; Materna, 2004; Materna, 2009; Duží *et al.*, 2010). Informally, TIL is based on the notion of *construction*, an abstract procedure, which represents a way of arriving at an object (Materna, 2009) and thus captures the notion of *non-canonical object* such as $1 + 1$ in N, where 2 would the it's canonical counterpart.

The relation between constructive type theory and TIL's approach to natural language analysis needs further investigation. Both approaches nevertheless share some core assumptions such as keeping form and content together or a credo that formalisation is not a translation, but rather explicit exposition of the structure of a (natural) language, in other words, the formalism comes equipped with explicit interpretation. This sets both approaches apart with traditional model-theoretic formal semantics. See (Materna, 2008) for discussion on the relation between TIL and proof-theoretic approaches and (Moschovakis, 1994; Moschovakis, 2006) for discussion of Fregean sense and denotation as algorithm and value and (Muskens, 2005) for more accessible interpretation of the same idea.

3.3 Condition of concurrency

At the end we want to introduce an event based constraint on co-predication. Let us illustrate this on an example of *tuna*. We will be concerned with countable and uncountable meanings of the word, i.e. a *tuna* as an animal and as meat. The transformation of an animal into meat is usually referred to as *grinding*. Bassac *et al.* (2010) propose that grinding polysemies can be uniformly handled by global evaluation of the argument, because there does not seem to be an attested co-predication example involving tuna as an animal and as a meat. See, however, (Nunberg, 1995) or (Rumshisky *et al.*, 2007) for counterexamples, which show that grinding polysemies could also be susceptible to co-predication, even though in very limited number of cases. The conclusion of (Nunberg, 1995) seems to be that, given a sufficient context, almost any grinding co-predication can be interpreted. Nunberg calls the condition *noteworthiness*: as long as the animal predication contributes some property to the meat predication (such as *feed-eat*, meaning that what the animal is fed contributes to the quality of it's meat), the whole expression can be interpreted.

We would like to propose a constraint, which we will refer to as *condition of concurrency.* The example (15) and (16) involve time factor. *Tuna* cannot be used as an animal and food at the same time frame[6]. Thus for co-predication to be possible, the two sorts must be able to co-exist. Consider, however, example (18) where the predication of *small* 'animal' and *delicious* 'meat' seems to be concurrent. It seems that a fully satisfactory analysis of co-predication has to be based on analysis of event structure of the predicates and in particular on the ontological constraints limiting co-existence of sorts.

Example (17) suggests that *tuna* cannot be the same semantic object, even though it is naturally a single object syntactically. This would also suggest that anaphora works syntactically and the semantic evaluation is done locally (i.e. by local evaluation in the system of (Bassac *et al.*, 2009) in "call-by-name" fashion).

(15) That tuna put up a good fight and it was delicious.

(16) That tuna put up a good fight, but it was delicious.

(17) The tuna that put up a good fight is/was delicious.

(18) The small tuna is delicious.

[6] The question of eating live animals is put aside, assuming, however, that an animal, dead or alive, becomes meat when served with the purpose to be eaten.

4 Summary

We have tried to show that lexical meanings can be formalised by structured means instead of plain set-theoretical objects and that such approach to lexical meaning would enable a flexible treatment of problems that otherwise seem to require formally complicated and ontologically dubious notions such as dot objects.

We have tried to demonstrate a constructive type theoretical treatment of meaning and sense that provides a rich and realistic account of lexical semantic phenomena. In passing we have also suggested that also *procedural* approach of TIL could be viable alternative for a formal account of lexical semantics.

Finally, we have proposed an outline of a flexible architecture for *constructive predication*, which is closely related to semantic networks, semantic web and particularly to neural network approaches.

Our ongoing and future work is focused on the conditions that give rise to facets and especially on the interaction between the component sorts as well as further formalisation of the notion of constructive predication. An implementation that would allow experiments should follow.

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