Coping with Construals in Broad-Coverage Semantic Annotation of Adpositions

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Abstract

We consider the semantics of prepositions, revisiting a broad-coverage annotation scheme used for annotating all 4,250 preposition tokens in a 55,000 word corpus of English. Attempts to apply the scheme to adpositions and case markers in other languages, as well as some problematic cases in English, have led us to reconsider the assumption that a preposition's lexical contribution is equivalent to the role/relation that it mediates. Our proposal is to embrace the potential for **construal** in adposition use, expressing such phenomena directly at the token level to manage complexity and avoid sense proliferation. We suggest a framework to represent both the scene role and the adposition's lexical function so they can be annotated at scale—supporting automatic, statistical processing of domain-general language—and sketch how this representation would inform a constructional analysis.

1 Introduction

A consequence of the vast expressiveness of human language is that natural language understanding (NLU) cannot scale to *general language* input unless it is willing to make some compromises for the sake of practicality and robustness. One such compromise made in most state-of-the-art natural language processing technologies (e.g., syntactic parsing) is that the computational model of language is not a complete model of human grammatical knowledge, but rather, a set of soft preferences derived by statistical learning algorithms from large human-annotated datasets. Thus, a strategy for advancing the state-of-the-art in NLU is to focus linguists' descriptive effort on *annotation schemes* and *datasets*: annotating corpora with semantic information, for instance, so that formal cues (denotational or contextual) can be automatically associated with meaning representations. A representation will necessarily be limited in the level of detail it provides (its *granularity*) and/or the range of linguistic expressions that it is prepared to describe (its *coverage*). The principles of Construction Grammar can inform corpus annotations even if they fall short of full-fledged constructional parses.

Mindful of this granularity–coverage tradeoff, we have sought to develop a scheme that will be of practical value for broad-coverage human annotation, and therefore domain-general NLU, for a particular set of lexicogrammatical mark-ers: **prepositions** in English, and more generally, **adpositions** and **case markers** across languages. Forming a relatively closed class, these markers are incredibly versatile, and therefore exceptionally challenging to characterize semantically, let alone disambiguate automatically (§2).

As a first step, we describe **preposition supersenses**, which target a coarse level of granularity and support comprehensive coverage of types and tokens in English. However, in attempting to generalize this approach to other languages, we uncovered a major weakness: it does not distinguish the contribution of the preposition itself, i.e., what the adposition **codes** for, from the semantic role or relation that the adposition mediates and that a predicate or scene **calls** for; and as a result, the label that would be most appropriate is underdetermined for many tokens (§3). In our view, the mismatch can be understood through the lens of **construal** and should be made explicit, leveraging the principles of Construction Grammar (§4). §5 surveys some of the phenomena that our new analysis addresses; §6 discusses the tradeoffs inherent in the proposed approach. Finally, we sketch how our proposal would fit into a compositional constructional analysis of adpositional phrases (§7).
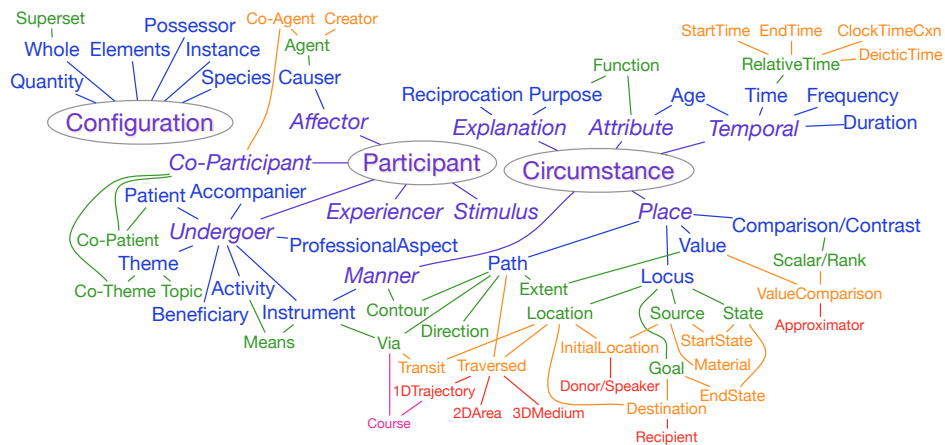
2 Approaches to Prepositional Polysemy

The most frequent English prepositions are extraordinarily polysemous. For example, the preposition **at** expresses different information in each of the following usages:

(1)   a. The coffee shop is **at** 123 Main St. (LOCATION)
     b. We met him **at** 7pm. (TIME)
     c. Suddenly, everyone pointed **at** him. (GOAL)
     d. She laughed **at** my acting. (STIMULUS)
     e. They were robbed **at** gunpoint. (INSTRUMENT)

NLU systems, when confronted with a new instance of **at**, must determine whether it marks an entity or scene's location, time, instrument, or something else.

As lexical classes go, prepositions are something of a red-headed stepchild in the linguistics literature. Most of the semantics literature on prepositions has revolved around how they categorize space and time (e.g., Herskovits, 1986; Verkuyl and Zwarts, 1992; Bowerman and Choi, 2001). However, there have been a couple of lines of work addressing preposition semantics broadly. In cognitive linguistics, studies have examined abstract as well as concrete uses of English

Superset
Whole Elements Possessor Co-Agent Creator
Quantity Instance Agent
Species Causer
StartTime EndTime ClockTimeCxn
RelativeTime DeicticTime
Configuration
Affector
Reciprocation Purpose Function
Explanation Attribute Age Time Frequency
Temporal Duration
Co-Participant Participant Circumstance
Patient Accompanier
Co-Patient Undergoer Experiencer Stimulus Place Comparison/Contrast
Theme ProfessionalAspect Value Scalar/Rank
Co-Theme Topic Activity Manner Path Locus ValueComparison
Beneficiary Instrument Contour Extent Approximator
Means Direction Location Source State
Via StartState
Transit InitialLocation Goal Material
1DTrajectory Traversed Donor/Speaker EndState
Course 2DArea 3DMedium Destination
Recipient

Figure 1: Preposition supersense hierarchy (from Schneider et al., 2016). Top-level categories are circled and subcategories radiate outward.

prepositions (e.g., Dirven, 1993; Lindstromberg, 2010). Notably, the polysemy of **over** and other prepositions has been explained in terms of sense networks encompassing core senses and motivated extensions (Brugman, 1981; Lakoff, 1987; Dewell, 1994; Tyler and Evans, 2001, 2003). The Preposition Project (TPP; Litkowski and Hargraves, 2005) broke ground in stimulating computational work on fine-grained word sense disambiguation of English prepositions (Litkowski and Hargraves, 2005; Ye and Baldwin, 2007; Tratz and Hovy, 2009; Dahlmeier, Ng, and Schultz, 2009). Typologists, meanwhile, have developed *semantic maps* of functions, where the nearness of two functions reflects their tendency to fall under the same adposition or case marker in many languages (Haspelmath, 2003; Wälchli, 2010).

Preposition supersenses. Following Srikumar and Roth (2013), we sought coarse-grained semantic categories of prepositions as a broader-coverage alternative to fine-grained senses. Because we want our labels to generalize across languages, we use categories similar to those appearing in semantic maps (LOCATION, RECIPIENT, etc.) rather than lexicalized senses. We identified a set of such categories through extensive deliberation involving the use of dictionaries, corpora and pilot annotation experiments (Schneider et al., 2015). We call these categories **supersenses** to emphasize their similarity to coarse-grained classifications of nouns and verbs that go by that name (Ciaramita and Altun, 2006; Schneider et al., 2012). The **at** examples in (1) are accompanied by the appropriate supersenses from our scheme. Most supersenses resemble thematic roles, in the tradition begun by Fillmore (1968); a few others are needed to describe preposition-marked relations between entities. There are multiple English prepositions per supersense; e.g., "**in** the city" and "**on** the table" would join "**at** 123 Main St." in being labeled as LOCATIONs. We understand the supersenses as prototype-based categories, and in some cases use heuristics like paraphraseability ("in order to" for PURPOSE) and WH-question words ("Why?" for PURPOSE and EXPLANATION) to help determine which tokens are instances of the category.

The 75 supersenses are organized in a taxonomy based on that of VerbNet (Bonial et al., 2011), with PARTICIPANT,

CIRCUMSTANCE, and CONFIGURATION at the top level.[1] The taxonomy uses multiple inheritance to account for subcategories which are considered to include properties of multiple supercategories. The full hierarchy appears in figure 1.

Our approach to preposition annotation is *comprehensive*, i.e., every token of every preposition type is given a supersense label. We applied the supersenses to annotate a 55,000 word corpus of online reviews in English, covering all 4,250 preposition tokens (Schneider et al., 2016). For each token, annotators chose a single label from the inventory. This is not an easy task, but with documentation of many examples in a lexical resource, **PrepWiki**,[2] trained university students were able to achieve reasonable levels of inter-annotator agreement. Every token was initially labeled by at least two independent annotators, and differences were adjudicated by experts.

3 Problems with Preposition Supersenses

While the above approach worked reasonably well for most English tokens, a few persistent issues arising in English and other languages have led us to revisit fundamental assumptions about what it means to semantically label an adposition.

3.1 Semantic Overlap

In our original English annotation (Schneider et al., 2016), a few phenomena caused us much hand-wringing—not because there was no appropriate supersense, but because *multiple* supersenses seemed to fit. For example, we found that TOPIC and STIMULUS could compete for semantic territory.

(2) evinces related usages of **about** with different governors:

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[1] These loosely correspond to event arguments, adjuncts, and adnominal complements, respectively. However, we do not make any claims with regard to coreness or the argument/adjunct distinction, as there are many phenomena that do not conform to either of the prototypes for argument and adjunct (for a review of the literature on the argument/adjunct distinction, see Hwang, 2011). We are also not convinced that a firm distinction between lexical and nonlexical/functional adpositions (Rauh, 1993) can be established, though the relevance of this distinction in the context of the bipartite construal approach merits further investigation.

[2] http://tiny.cc/prepwiki

(2) a. I read [a book **about** the strategy].

   b. I read **about** the strategy.

   c. I knew **about** the strategy.

   d. I cared **about** the strategy.

The first three usages could reasonably be labeled as TOPIC. This is because the **about**-PP indicates what is communicated (2a, 2b) and known (2c). The fourth example (2d), however, presents an overlap in its interpretation. On the one hand, traditional thematic role inventories include the category STIMULUS for something that prompts a perceptual or emotional experience, as in (3).

(3) I was afraid **of** the strategy.

Surely, *cared* in (2d) describes an emotional state, so **about** marks the STIMULUS. However, much like examples (2a–2c), the semantics relating to TOPIC is still very much present in the use of **about**, which draws attention to the aspects of the caring process involving thought or judgement. This sits in contrast to the use of **for** in "I cared **for** my grandmother," where the prepositional choice calls attention to the benefactive aspect of the caring act.

If we are constrained to one label per argument, where should the line be drawn between STIMULUS and TOPIC in cases of overlap? In other words, should the semantic representation emphasize the semantic commonality between all of the examples in (2), or between (2d) and (3)?

Observing that annotators were inconsistent on such tokens, we drew a boundary between TOPIC and STIMULUS in an attempt to force consistency. Below, we instead argue that the idea of construal/conceptualization offers a more principled answer; in our new analysis, the TOPIC suggested by **about** and the STIMULUS suggested by *cared* can coexist.

3.2 Applying the Supersenses to Other Languages

One of the premises of using unlexicalized supersenses was that the scheme would port well to other languages (as the WordNet noun and verb supersenses have: Picca, Gliozzo, and Ciaramita, 2008; Schneider et al., 2012, *inter alia*). To test this, we have begun applying the existing supersenses to three new languages, namely, Hebrew, Hindi, and Korean. Pilot annotation in these languages has echoed the fundamental problem discussed in the previous section.

Consider the Hindi examples below. In (4a), the experiencer of an emotion is marked with a postposition **kaa**, the genitive case marker in Hindi. The use of **kaa** strongly suggests possession (here it is possession of an abstract quality). However, the semantics of the phrase also includes EXPERIENCER—thus, it seems inappropriate to choose between EXPERIENCER and POSSESSOR for this token. (The same problem is encountered with a similar phrase "the anger **of** Bipasha" in English.) There are other ways to attribute anger to Bipasha—e.g., see (4b). Here Bipasha is not construed as a possessor when the postposition **kaa** is not used.

(4) a. [Hindi]: EXPERIENCER vs. POSSESSOR
     bipaashaa **kaa** gussaa
     Bipasha **GEN** anger
     "Bipasha's anger"

   b. [Hindi]: EXPERIENCER
     bipaashaa bahut gussaa hui
     Bipasha very angry became
     "Bipasha got very angry."

Our preliminary annotation of Hindi, Korean, and Hebrew has suggested that instances of overlap between multiple supersenses are fairly frequent.

4 Bipartite Construal Analysis

Why do "cared **about** the strategy" in (2d) and "anger **of** Bipasha" in (4a) above not lend themselves to a single label? These seem to be symptoms of the fact that no English preposition prototypically marks EXPERIENCER or STIMULUS roles, though from the perspective of the predicates, such roles are thought to be important generalizations in characterizing events of perception and emotion. In essence, there is an apparent mismatch between the roles that the verb *care* or the noun *anger* calls for, and the functions that English prepositions prototypically code for. While **about** prototypically codes for TOPIC and **of** prototypically codes for POSSESSOR, there is no preposition that "naturally" codes for EXPERIENCER or STIMULUS in the same way. Thus, if a predicate marks an EXPERIENCER or STIMULUS with a preposition, the preposition will contribute something new to the conceptualization of the scene being described. With "cared **about** the strategy," it is TOPIC-ness that the preposition brings to the table; with "anger **of** Bipasha," it is the conceptualization of anger as an attribute that somebody possesses.

Thus, we turn to the theories in Cognitive Semantics to define the phenomenon of **construal** as a means of understanding the contributions that are emerging from the adpositions with respect to the expressed event or situation. Then, we turn to the guiding principles of Construction Grammar to develop a method called **bipartite analysis** in order to handle the problem posed by construals and to resolve the apparent semantic overlap which is pervasive across languages.

4.1 Construal

The world is not neatly organized into bits of information that map directly to linguistic symbols. Rather, linguistic meaning reflects the priorities and categorizations of particular expressions in a language (Langacker, 1998; Jackendoff, 2002; Croft and Cruse, 2004, ch. 3). Much like pictures of a scene from different viewpoints will result in different renderings, a real-world situation being described will "look" different depending on the linguistic choices made by a speaker. This includes within-language choices: e.g., the choice of "John sold Mary a book" vs. "John sold a book to Mary" vs. "Mary bought a book from John." In the process called **construal** (a.k.a. **conceptualization**), a speaker "packages" ideas for linguistic expression in a way that foregrounds certain elements of a situation while backgrounding others.

We propose to incorporate this notion of construal in adposition supersense annotation. We use the term **scene** to refer to events or situations in which an adpositional phrase plays a role. (We do not formalize the full scene, but assume its roles can be characterized with supersense labels from figure 1.) Contrast the use of the prepositions **by** and **of** in (5):

(5) a. The festival focuses on the works **by** Puccini.

   b. He was an expert on the works **of** Puccini.

While both prepositional phrases indicate works created by the operatic composer Puccini (i.e., CREATOR), the different choices of preposition reflect different construals: **by** highlights the agency of Puccini, whereas **of** construes Puccini as the source of his composition. Thus, "works **by** Puccini" and "works **of** Puccini" are paraphrases, but present subtly different portrayals of the relationship between Puccini and his works. In other words, these paraphrases are not identical in meaning because the preposition carries with it different nuances of construal. In this paper, we focus on differences in construal manifested in different adposition choices, and the possibility that an adposition construal complements the construal of a scene and its roles (as evoked by the governing head or predicate).

For instances like "I read **about** the strategy" in (2b) that were generally unproblematic for annotation under the original preposition guidelines, the semantics of the adposition and the semantic role assigned by the predicate are congruent. However, for examples like "cared **about** the strategy" in (2d) and "anger **of** Bipasha" in (4a), we say that the adposition construes the role as something other than what the scene specifies. Competition between different adposition construals accounts for many of the alternations that are near-paraphrases, but potentially involve slightly different nuances of meaning (e.g., "talk **to** someone" vs. "talk **with** someone"; "angry **at** someone" vs. "angry **with** someone").

Thus, the notion of construal challenges Schneider et al.'s (2015; 2016) original conception that each supersense reflects the semantic role assigned by its governing predicate (i.e. verbal or event nominal predicate), and that a single supersense label can be assigned to each adposition token. Rather than trying to ignore these construals to favor a single-label approach, or possibly create new labels to capture the meaning distinctions that construals impose on semantic roles, we adopt an approach that gives us the flexibility to deal with both the semantics coming from the scene as well as the construals imposed by the adpositional choice.

4.2 Formulating a Bipartite Analysis

We address the issues of construal by proposing a **bipartite analysis** that decouples the semantics signaled by the adposition from the role expected by the scene. Essentially, we borrow from Construction Grammar (Fillmore, Kay, and O'Connor, 1988; Kay and Fillmore, 1999; Goldberg, 2006) the notion that semantic contributions can be made at various levels of syntactic structure, beginning with the semantics contributed by the lexical items.

Under our original single-label analysis, the full weight of semantic assignment rested on the predicate's semantic role, with the indirect assumption that the predicate selects for adpositions relevant to the assignment. Under the bipartite analysis, we assign semantics at both scene and adposition levels of meaning: we capture what the scene *calls* for, henceforth **scene role** and what the adposition itself *codes* for, henceforth **function**. Both labels are drawn from the supersense hierarchy (figure 1). Allowing tokens to be annotated with

both a role and a function accounts for the non-congruent adposition construals, as in (6).

(6) a. The festival focuses on the works **by** Puccini.
    scene role: CREATOR vs. function: AGENT

   b. He was an expert on the works **of** Puccini.
    scene role: CREATOR vs. function: SOURCE

Bipartite analysis recognizes that both of these sentences carry the meaning represented by the supersense CREATOR at the scene level, but also allows for the construal that arises from the chosen preposition: **by** is assigned the function of AGENT and **of** is assigned the function of SOURCE.

Our bipartite annotation scheme does not require a syntactic parse. It therefore does not provide a full account of constructional compositionality. The scene that the PP elaborates may take a variety of syntactic forms; we aim to train annotators to interpret the scene without annotating its lexical/syntactic form explicitly. In §7, we sketch how a compositional Construction Grammar analysis could capture the function and the scene role at different levels of structure.

5 Applying the Bipartite Analysis

In this section, we discuss some of the more productive examples of non-congruent construals in English as well as in Hindi, Korean, and Hebrew. Hereafter, we will use the notation ROLE⤳FUNCTION to indicate such construals. Adopting the "realization" metaphor of articulating an idea linguistically, this can be read as "ROLE is realized with an adposition that marks FUNCTION."

5.1 Emotion and Perception Construals

Scenes of emotion and perception (Dirven, 1997; Osmond, 1997; Radden, 1998) provide a compelling case for the bipartite construal analysis. Consider the sentences involving emotion in example (7):

(7) a. I was scared **by** the bear.
    STIMULUS⤳CAUSER

   b. I was scared **about** getting my ears pierced.
    STIMULUS⤳TOPIC

Comparing examples (7a) and (7b), we notice that there are two different types of stimuli represented in otherwise semantically parallel sentences. The preposition **by** gives the impression that the stimulus is responsible for triggering an instinctive fear reflex (i.e., CAUSER), while **about** portrays the thing feared as the content or TOPIC of thought.[3]

In some languages, the experiencer can be conceptualized as a recipient of the emotion or feeling, thus licensing dative marking.[4] In the Hebrew example (8a), the experiencer of bodily perception is marked with the dative preposition **l(e)-** (Berman, 1982). Similarly, in Hindi, the dative postposition **-ko** marks an experiencer in (8b).

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[3]Interestingly, "scared **about**" seems to require an explicit or metonymic event/situation as the complement. Thus, "scared **about** the bear" would be felicitous to describe apprehension about some mischief that the bear might get up to. It would be less than felicitous to describe a hiker's reaction upon being surprised by a bear.

[4]English displays this to a limited extent: "It feels/seems/looks perfect **to** me."

(8) a. [Hebrew]: EXPERIENCER⤳RECIPIENT
Koev **l**-i ha-rosh
Hurts **DAT**-me the-head
"My head hurts."

b. [Hindi]: EXPERIENCER⤳RECIPIENT
mujh-**ko** garmii lag rahii hai
I-**DAT** heat feel PROG PRES
"I'm feeling hot."

Contrast this with examples where scene role and adposition function are congruent:

(9) a. I ate dinner **at** 7:00: TIME⤳TIME
b. Let's talk **about** our business plan: TOPIC⤳TOPIC

In (9a) and (9b), the preposition is prototypical for the given scene role and its function directly identifies the scene role. Because the semantics of the role and function are congruent, these cases do not exhibit the extra layer of construal seen in (7) and (8).[5] In essence, the bipartite analysis help capture the construals that characterize the less prototypical scene role and function pairings.

5.2 Professional Associate Construals

Our online reviews corpus (Schneider et al., 2016) shows that, at least in English, professional relationships (especially employer–employee and business–client ones) are fertile ground for alternating preposition construals. The following were among the examples tagged as PROFESSION-ALASPECT:[6]

(10) a. My dad worked **for** a record label in the 1960's.
PROFESSIONALASPECT⤳BENEFICIARY

b. Dr. Strzalka **at** Flagship CVTS is not a good doctor.
PROFESSIONALASPECT⤳LOCATION

c. Nigel **from** Nidd Design has always been great!
PROFESSIONALASPECT⤳SOURCE

d. the owners and employees **of** this store
PROFESSIONALASPECT⤳POSSESSOR

All of these construals are *motivated* in that they highlight an aspect of prototypical professional relationships: e.g., an employee's work prototypically takes place at the business location (hence "work **at**"), though this is not a strict condition for using "work **at**"—the meaning of **at** has been extended from the prototype. Likewise, the pattern "*person* {**at**, **from**, **of**} *organization*" has been conventionalized to signify employment or similar institutional-belonging relationships.

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[5]One might object that most or all adpositions impose a spatial construal—and thus, (9a) should be annotated as TIME⤳LOCATION. We do not discount the possibility that such a metaphor can be cognitively active in speakers using temporal adpositions; in fact, there is considerable evidence that time-as-space metaphors are cross-linguistically pervasive and productive (Lakoff and Johnson, 1980; Núñez and Sweetser, 2006; Casasanto and Boroditsky, 2008). However, we do not see much practical benefit to annotating temporal **at** or topical **about** as spatial.

[6]We are considering replacing PROFESSIONALASPECT with a broader category called SOCIALREL that would additionally encompass kinship and other relations between persons.

Bipartite analysis equips us with the ability to use the existing labels like BENEFICIARY or CO-AGENT to deal with the overloading of the PROFESSIONALASPECT label, instead of forcing a difficult decision or creating several additional categories. This analysis also accounts for similar construals presented by adpositions in other languages. For example, the overlap of PROFESSIONALASPECT with SOURCE, as seen in English example (10c), occurs in Hindi and Korean as well.

5.3 Static vs. Dynamic Construals

Another source of difficulty in the original annotation came from caused-motion verbs like *put*, which takes a PP indicating part of a path. Sometimes the preposition lexically marks a source or goal, e.g., **into**, **onto**, or **out of** (11a). Often, however, the preposition is prototypically locative, e.g., **in** or **on** (11b), though the object of the preposition is interpreted as a destination, equivalent to the use of **into** or **onto**, respectively. This locative-as-destination construal is highly productive, so analyzing **on** as polysemous between LOCATION and DESTINATION does not capture the regularity. The PP is sometimes analyzed as a resultative phrase (Goldberg, 2006). In our terms, we simply say that the scene calls for a DESTINATION, but the preposition codes for a LOCATION:

(11) a. Cynthia put her things **into** a box.
DESTINATION⤳DESTINATION

b. Cynthia put her things **on** her bed.
DESTINATION⤳LOCATION

Thus, we avoid listing the preposition with multiple lexical functions for this regular phenomenon.

The opposite problem occurs with fictive motion (Talmy, 1996): a path PP, and sometimes a motion verb, construe a static scene as dynamic:

(12) A road runs **through** my property. LOCATION⤳PATH

Rather than forcing annotators to side with the dynamic construal effected by the language, versus the static nature of the actual scene, we represent both: the scene role is LOCATION (static) and the preposition function is PATH (dynamic).

6 Challenges and Opportunities

The added representational complexity of the bipartite analysis seems justified to account for many of the phenomena discussed above, especially as the project grows to include more languages. But is the complexity worth it on balance? We consider some of the tradeoffs below.

6.1 Challenges in Function Assignment

We encountered several examples in which function labels are difficult to identify. Consider the following paraphrases:

(13) a. [Korean]: LOCATION⤳LOCATION
Cheolsu-nun undongcang-**eyse** tallyessta.
Cheolsu-NOM schoolyard-**at** ran.
"Cheolsu ran in the schoolyard."

b. [Korean]: LOCATION⤳?
Cheolsu-nun undongcang-**ul** tallyessta.
Cheolsu-NOM schoolyard-**ACC** ran.
"Cheolsu ran in the schoolyard."

In (13a), "schoolyard" is accompanied by a postposition **-eyse** (comparable to English **at**), which marks it as the location of running. This is the unmarked choice. On the other hand, in sentence (13b), the noun is paired with the accusative marker **-ul**, the marked choice. The use of **-ul** evokes a special construal: it indicates that the schoolyard is more than just a backdrop of the running act and that it is a location that Cheolsu mindfully chose as the place of action. Additionally, marking the location with the accusative marker, pragmatically, brings focus to the noun (i.e., he ran in a schoolyard as opposed to anywhere else). Such construals are not limited to locations, but may also include other scene roles such as GOAL and ACCOMPANIER, in alternation with postpositions that can express those functions. Since accusative case markers generally serve syntactic functions over semantic ones, it may be difficult to identify a semantic function the accusative marker carries.

A similar phenomenon can be found in Hindi:

(14) a. [Hindi]: bare NP as DESTINATION
maiN library jaa rahii thii
I library go PROG PST
"I was going to the library."

   b. [Hindi]: DESTINATION⤳?
maiN library-**ko** jaa rahii thii
I library-**ACC** go PROG PST
"I was going to the LIBRARY." [more emphasis on the library]

This suggests that, apart from spatiotemporal relations and semantic roles, adpositions can mark **information structural** properties for which we would need a separate inventory of labels.

In some idiomatic predicate–argument combinations, the semantic motivation for the preposition may not be clear (15).

(15) a. Listen **to** the violin! STIMULUS⤳?
   b. What are you proudest **of**? STIMULUS⤳?
   c. I was unhappy **with** my meal. STIMULUS⤳?
   d. Are you interested **in** politics? TOPIC⤳?

While the scene role in (15a) and (15b) is clearly STIMULUS, the function is less clear. Is the object of attention construed (metaphorically) as a GOAL in (15a), and the cause for pride as a SOURCE in (15b)? Or are **to** and **of** semantically empty argument-markers for these predicates (cf. the "case prepositions" of Rauh, 1993)? We do not treat either combination as an unanalyzable multiword expression because the ordinary meaning of the predicate is very much present. (15c) and (15d) are similarly fraught. But as we look at more data, we will entertain the possibility that the function can be null to indicate a marker which contributes no lexical semantics.

6.2 The Annotation Process

Annotators are generally capable of interpreting meaning in a given context. However, it might be difficult to train annotators to develop intuitions about adposition functions, which reflect prototypical meanings contributed by the lexical item that may not be literally applicable. These distinctions may be too subtle to annotate reliably. As we are approaching this project with the goal of producing annotated datasets for training and evaluating natural language understanding systems, it is an important concern.

We are currently planning pilot annotation studies to ascertain (i) the prevalence of the role vs. function mismatches, and (ii) annotator agreement on such instances. Enshrining role–function pairs in the lexicon may facilitate inter-annotator consistency: our experience thus far is that annotators benefit greatly from examples illustrating the possible supersenses that can be assigned to a preposition. If initial pilots are successful, we would then need to decide whether to annotate the role and function together or in separate stages. Because the function reflects one of the adposition's prototypical senses, it may often be deterministic given the adposition and scene role, in which case we could focus annotators' efforts on the scene roles. Existing annotations for lexical resources such as PropBank (Palmer, Gildea, and Kingsbury, 2005), VerbNet (Kipper et al., 2008), and FrameNet (Fillmore and Baker, 2009) might go a long way toward disambiguating the scene role, limiting the effort required from annotators.

6.3 Linguistic Utility of Annotated Data

Assuming the above theoretical and practical concerns are surmountable, annotated corpora would facilitate empirical studies of the nature and limits of adposition/case construal within and across languages. For example: Is it the case that some of the supersense labels can only serve as scene roles, or only as functions? (A hypothesis is that PARTICIPANT subtypes tend to be limited to scene roles, but this needs to be examined empirically.) Which role–function pairs are attested in particular languages, and are any universal? Thus far we have seen that certain scene roles, such as EXPERIENCER, STIMULUS, and PROFESSIONALASPECT, invite many different adposition construals—is this universally true? As adpositions are notoriously difficult for second language learners, would it help to explain which construals do and do not transfer from the first language to the second language?

6.4 Modifying the Supersense Hierarchy

The bipartite analysis may allow us to trade more complexity at the token level for less complexity in the label set. As discussed in §4, separating the scene role and function levels of annotation will more adequately capture construal phenomena without forcing an arbitrary choice between two labels or introducing further complexity into the hierarchy. In fact, we hope to *simplify* our current supersense hierarchy, especially by removing labels with multiple inheritance for usages that can be accounted for with the bipartite analysis instead. Candidates include CONTOUR (inheriting from PATH and MANNER; e.g., "The fly flew **in** zig-zags") and TRANSIT (inheriting from VIA and LOCATION; e.g., "We traveled **by** bus"). We may also collapse the pairs LOCUS/LOCATION, SOURCE/INITIALLOCATION, and GOAL/DESTINATION. A simpler hierarchy of supersenses will serve to reduce the number of labels for annotators to consider during the annotation process and also help improve automatic methods by reducing sparsity of labels in the data.

7 Discussion of Constructional Analysis

We have focused on developing a *broad-coverage* annotation scheme for adpositional semantics, and our proposal requires no more than two categorical labels per adposition token (but see below). Although our current approach falls short of a full constructional derivation of the form–meaning correspondences that comprise a sentence and the interpretation that results, we believe our approach could inform such an analysis.

Construction Grammar formalisms that support full-sentence analyses include Embodied Construction Grammar (Bergen and Chang, 2005), Fluid Construction Grammar (Steels, Östman, and Ohara, 2011), and Sign-Based Construction Grammar (Boas and Sag, 2012). Without tying ourselves to any one of these, we observe at a high level that the lexical semantic contribution of the adposition (the function) can be distinguished from the role of a governing predicate or scene by assigning these meanings to different stages of the derivation. E.g., in "care **about** the strategy," the adposition and PP could express a TOPIC figure-ground relation whose ground is the meaning of "the strategy"; "care" could evoke a semantic frame with a STIMULUS role; and an argument structure construction could link the ground of the figure-ground relation with the STIMULUS role. If the STIMULUS⤳TOPIC construal with **about** is sufficiently productive, the generalization could be formalized via an argument-structure construction with a verb slot limited to verbs of (say) emotion and a PP headed by topical **about**.

There are complications which we are not yet prepared to fully address. First, if the PP is not governed by a predicate which provides the roles—such as a verb or eventive/relational noun—the preposition may need to evoke a meaning more specific than our labels. E.g., for "children **in** pajamas" and "woman **in** black," **in** may be taken to evoke the semantics of wearing clothing.[7] The label set we use for broad-coverage annotation is, of course, vaguer, and would simply specify ATTRIBUTE for the clothing sense of **in**. Copular constructions raise similar issues. Consider "It is **up to** you to decide," meaning that deciding is the addressee's responsibility: this idiomatic sense of **up to** is closer to a semantic predicate than to a semantic role or figure-ground relation.

In rare instances, we are tempted to annotate a chain of extensions from a prototypical function of a preposition, which we term **multiple construal**. For instance:

(16) a. Bob's boss yelled **at** him for his mistake.
　　　RECIPIENT⤳BENEFICIARY⤳GOAL

　　b. Bob's boss was angry **at** him for his mistake.
　　　STIMULUS⤳BENEFICIARY⤳GOAL

　　c. I was involved **in** the project.
　　　THEME⤳SUPERSET⤳LOCATION

"Yelled **at**" in (16a) is a communicative action whose addressee (RECIPIENT) is also a target of the negative emotion (BENEFICIARY⤳GOAL: compare the use of **at** in "shoot **at**

the target"). (16b) is similar, except "angry" focuses on the emotion itself, which Bob is understood to have evoked in his boss.

With regard to (16c), the item "involved **in**" has become fossilized, with **in** marking an underspecified noncausal participant (hence, THEME as the scene role). At the same time, one can understand the **in** here as motivated by the member-of-set sense (cf. "I am **in** the group"), which would be labeled SUPERSET⤳LOCATION because it conceptualizes membership in terms of containment. A similar logic would apply to "people **in** the company": PROFESSIONALASPECT⤳SUPERSET⤳LOCATION. Effectively, the multiple construal analysis claims that multiple steps of extending a preposition's prototypical meaning remain conceptually available when understanding an instance of its use. That said, we are not convinced that this logic could be applied reliably by annotators, and thus may simplify the usages in (16) to just the first and second or the first and third labels.

Finally, metaphoric scenes (Lakoff and Johnson, 1980) raise a whole host of issues. In (17), the locative-as-destination construal (§5.3) is layered with the states-are-locations metaphor. In bipartite analysis, we annotate the scene in terms of the governing predicate's **target domain**, and the adposition function in terms of the **source domain**:

(17) The election news put him in a very bad mood.
　　　ENDSTATE⤳LOCATION

A constructional analysis could capture both source domains and both target domains—i.e., LOCATION, STATE, DESTINATION, and ENDSTATE–perhaps by assigning source domain meanings to lexical constructions and target domain meanings to their mother phrases.[8]

8 Conclusion

We have considered the semantics of adpositions and case markers in English and a few other languages with the goal of revising a broad-coverage annotation scheme used in previous work. We pointed out situations where a single supersense did not fully characterize the interaction between the adposition and the scene elaborated by the PP. In an attempt to tease apart the semantics contributed specifically by the adposition from the semantics coming from elsewhere, we proposed a bipartite construal analysis. Though many details remain to be worked out, we are optimistic that our bipartite analysis will ultimately improve broad-coverage annotations as well as constructional analyses of adposition behavior.

Acknowledgments

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[7]Indeed, this is the position adopted by version 1.7 of FrameNet, where **in** is listed as a lexical unit of the WEARING frame (https://framenet2.icsi.berkeley.edu/fnReports/data/frame/Wearing.xml).

[8]Dodge et al. (2014) similarly analyze "attacking poverty" by assigning the source domain meaning (i.e., a literal attack) to "attacking" and the target domain meaning ('solving a social problem') to the argument structure construction.

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