

Annotating Spatial Interpretations of German Prepositions

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Traditional approaches to prepositions classify preposition lexemes into different semantic classes like spatial, temporal or modal ones. In this paper we reconsider the so-called spatial prepositions and their subclassification. We propose a sense based classification of prepositions using traditional criteria to determine different classes of spatial-preposition interpretations. Our work on spatial preposition senses is part of a bigger project of developing an annotation scheme for a subset of German prepositions.

Prepositions; spatial; preposition senses; annotation scheme; German; classification

I. INTRODUCTION

An investigation of the semantics of prepositions in actual usage reveals their high potential to express relations in various dimensions. Traditionally, the subcategorization of prepositions is based on apparently predominant senses of the respective preposition, so that prepositions are called spatial, temporal, modal, and causal (among others). Recently, [1] has offered an alternative in starting from abstract notions that are organized in categories such as localization, quantity, manner, accompaniment, etc. All in all comprehensive approaches that try to systematically cover all possible senses of a preposition are seldom found, possible exceptions being the Preposition Project for English [2], and PrepNet for French [1].

The goal of the present study is the development of a comprehensive as well as differentiated annotation scheme for preposition senses, starting with an analysis of 22 simple German prepositions.¹

Currently, it serves two purposes: First, the annotation scheme is employed for manual annotation of preposition senses in a large corpus which has been compiled of newspaper issues of the Swiss German “Neue Zürcher Zeitung” (NZZ) from 1993 to 1999 (comprising 230 million words). Secondly, the annotation scheme as well as the annotated corpus should be used as a gold standard for the automatic classification of preposition senses.²

¹ A scheme for the annotation of preposition sense for German prepositions did not exist prior to our investigation. The 22 prepositions under investigation are those simple prepositions of German that select NP as well as bare N complements and govern a case.

² In addition to the annotation of preposition senses, the corpus is annotated with morphological, lexical, syntactic, and semantic markup. For further details as well as an example of the use of the scheme cf. [3].

In the present paper, we focus on the classification of spatial interpretations. Many studies examining the meaning of prepositions are situated in the domains of space and time. Spatial interpretations have received a lot of interest, as they often tend to be regarded as the primary and most prototypical senses. However, whether these relations should be modeled via geometrical relations or by means of symbolic logic is still a fundamentally controversial issue. Semanticists disagree as to whether the local placement should be analyzed in terms of a localization of objects or a localization of situations in their semantic representations (cf. [4]). In addition, we find huge differences with regard to the incorporation of a conceptual level (so-called *two-level approaches*, as e.g. [5], [6]), and also contextual or world knowledge.

We will take a stand on some of the concerns above and also present some new reflections with respect to theoretical questions that have not been touched yet to the best of our knowledge. Since this paper will focus on the annotation of spatial interpretations and – consequently – on the part of the scheme designed to capture this dimension, we refer the reader to [7] for a general picture.

As a starting point, we would like to state explicitly that we talk about spatial *interpretations* and not about spatial *prepositions*, as we adopt a perspective that we term a *relational* analysis of prepositions. A major feature of this view is that it is agnostic with respect to primary or prototypical meanings of prepositions. Instead, we assume that the prepositional system of a language is made up by associating sometimes arbitrary subsets of relational meanings to preposition lexemes. Let us illustrate this view with the preposition *über*, which is often classified as a spatial preposition and hence prototypically translated into English as *over* or *above*. The following examples show two different spatial interpretations in (1) and (2), and in addition, a sense referring to a HIERARCHICAL structure (3), and an ABOUTNESS interpretation in (4). While the first sentence is an example for the projective vertical use of *über*, the second one exemplifies a topological transit.

- (1) *Die Aktion dient der Navigationsschulung über
The operation serves the navigational training above
unbekanntem Gebiet.
unknown territory*

‘The navigational training above unknown territory is facilitated by this operation.’

- (2) *Die Erdgasleitung von Sibirien nach Westeuropa verläuft über polnisches Gebiet.*
The natural gas pipeline from Siberia to Western Europe runs through Polish territory

‘The natural gas pipeline from Siberia to Western Europe runs through Polish territory.’

- (3) *Die Truppen bedrohten die Oberhoheit Aserbeidschans über das Gebiet.*
The troops endangered the suzerainty of Azerbaijan over the territory

‘The troops endangered Azerbaijan’s suzerainty over the territory.’

- (4) *Irgendwie finden sie es lustig, ein Stück über Revolution zu machen.*
Somehow consider they EXPL funny a play about revolution to make

‘Somehow they see the fun in producing a play about revolution.’

Of course, one could think of prototypical spatial senses from which other senses are abstracted. It is thus not improbable to argue that a HIERARCHICAL sense goes back to a spatial relation that places one thing above or below another (cf. [8]). But this does not make the preposition inherently spatial, and a similar analysis cannot account for the ABOUTNESS sense in (4) which then has to be assumed as a second basic interpretation of *über*. Even if considering a spatial sense as the basic interpretation of *über*, one will have to decide which of the spatial senses should be the basic one. Let us assume the projective one is the underlying sense. A transit interpretation could be assumed as some kind of abstraction: the traversing object passes the reference object’s upside and thus can be located *above the reference object*. This characterization becomes inconclusive, once one considers examples like (5) in which the traversing object is not higher than the traversed.

- (5) *Sie wandern durch Tunnel über japanisches Gebiet.*
‘They march through tunnels through Japanese territory.’

What is more, it would be hard to explain why the transit interpretation of *über* shows similarities to an interpretation of *durch* (‘through’, ‘across’) (cf. section III.C for further discussions) without assuming a projective vertical interpretation as a basic interpretation of *durch*, too.

That a classification of preposition lexemes on the basis of their senses is not necessarily useful can also be illustrated by looking at a part of the prepositions that show a variety of other interpretations in addition to their ‘prototypical’ spatial interpretations, see Table a.

Given the huge diversity of interpretations of the prepositions in Table a, it remains unclear why the prepositions should be called spatial in the first place. Almost all of these spatial prepositions exhibit a temporal interpretation, too. Why

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Interpretation	Prototypical spatial prepositions										
	an	auf	bei	durch	gegen	hinter	in	neben	über	unter	vor
spatial	•	•	•	•	•	•	•	•	•	•	•
temporal	•	•	•		•		•		•	•	•
causal		•	•	•					•	•	•
conditional			•	•			•			•	
purpose		•									
concessive			•								
consecutive							•				
modal/manner		•	•	•			•		•	•	
circumstance		•	•				•			•	
medial		•		•			•		•	•	
instrumental	•	•		•			•		•	•	
participation										•	
correlation										•	
statement							•				
state							•			•	
hierarchy									•	•	
assignment	•	•					•			•	
order						•			•		•
transgression									•	•	
agent				•							
point of reference	•		•		•				•		
substitute		•									
exchange				•	•		•				
theme		•					•		•		
comparative					•			•			
restrictive										•	
copulative								•			
pros & cons					•						
adversative					•						•
distributive		•									
mereology	•										
target	•										
initiation						•					

Table a: Prepositions with prototypical spatial interpretations and other senses

not call them temporal or perhaps even instrumental prepositions? In addition, even if spatial senses are taken to be primary or prototypical, this does not account for prepositions that do not show spatial senses at all, or only in restricted contexts. Consider the prepositions *mit* (‘with’) and *ohne* (‘without’), which can be seen as antonyms in their sense PARTICIPATION. While the first preposition can indeed have a spatial interpretation in restricted contexts, viz. if the localized object is *in line with* to the reference object, the second preposition does not show a spatial sense at all.

Thus instead of assuming that spatial senses are primary or prototypical, we assume that subsets of relational senses can be assigned to prepositional lexemes, and that the presence of one sense is no prima facie argument for the existence of another for the same lexeme. This is what we call a relational analysis

of preposition senses. This relational view immediately accounts for translation mismatches between closely related languages. While English employs *over* for a projective vertical interpretation, German *über* is assigned a projective vertical interpretation, in addition to a sense of topological two-dimensional transit, and a nonspatial interpretation of ABOUTNESS. While the last is mapped to *about* in English, the second interpretation has to be realized through *across* and *through*.

The remaining paper is structured as follows: After some words on the annotation scheme in general, the paper will focus on the spatial interpretations of so-called spatial prepositions (cf. (8)). We will particularly consider the role of established terms like *topological* and *projective*, and point out the difficulties encountered.

II. GENERAL ARCHITECTURE OF THE ANNOTATION SCHEME

The annotation scheme has been implemented in the environment provided by the MMAX2 annotation tool (cf. [9]) and allows for an annotation in XML-stand-off format. We will just briefly mention the most important properties of the annotation scheme. An initial version of the scheme is presented in [10], a broader introduction is given in [7].

One of the most important features of the annotation scheme is its hierarchical organization. If senses can be subcategorized into discernible subsenses, the subsenses are structured in a classification tree that combines properties of a taxonomical structure with that of a decision tree (as will be illustrated with Figure 2 in section III.B). According to this view, SPATIAL and TEMPORAL are supersenses with a rich and diverse substructure. Given the incorporation of methods from taxonomies and decision trees, the annotator either has to choose between alternatives prescribed in the tree or has to decide about the membership to one of the available taxonomical classes. The temporal annotation tree (cf. [7]) is an illustration of the first method. It is based on an analysis of preposition choice, e.g. for language learners, in Durrell and Brée ([11]). Durrell and Brée wanted to offer guided choices from senses to lexemes. Our task is to decide from a given lexeme which sense is most plausible. We have appropriately modified their decision tree and added some senses that have not been covered by Durrell and Brée. The feasibility of the temporal annotation scheme is being shown in an inter-annotator study, cf. [10].

With regard to spatial senses, we initially implemented Schröder’s classification ([12]). Under closer scrutiny, however, it turned out to be inapplicable, and consequently has been replaced by the classification reported in the next chapter.

Before we turn to the analysis of spatial senses, we would like to address a general feature of the annotation scheme: It permits multiple annotations. Multiple annotations are useful in cases where discernible interpretations interact or are closely tied to one another.³ See e.g. (6), where a TEMPORAL

³ Prepositions can be seen as multifunctional in these cases, just like it is assumed for discourse markers (cf.[13]).

interpretation is as adequate as a CAUSAL one.⁴ In addition, multiple annotations are applicable to ambiguities that cannot be resolved without further context. This holds particularly if a broader context is not provided, as e.g. in headlines.⁵ The sentence in (7) lacking a verb is ambiguous as to whether the noun or the action is modified, meaning on the one hand that the leader has no point and returns (PRESENCE) or on the other hand that the leader returns without having made a point (CIRCUMSTANCE).

- (6) *Grossfeuer nach Blitzschlag in Tramelan*
(NZZ_1993_08_17_a135_seg9_s1, Headline: yes)
‘Serious fire in Tramelan after/because of lightning stroke’
- (7) *Der Leader ohne Punkt aus Sitten zurück*
(NZZ_1994_03_14_a123_seg1_s1, Headline: yes)
‘The leader without a point back from Sion’

III. SPATIAL INTERPRETATIONS OF PREPOSITIONS

In this section we present the part of our annotation scheme that has been designed to account for spatial interpretations. From the subset of 22 German prepositions, we have identified those in (8) as prepositions that show a spatial interpretation (the subset of so-called prototypical prepositions was listed in Table a). Other prepositions that may have prototypical spatial interpretations but are beyond that range will be left aside.

- (8) *an, auf, bei, durch, gegen, hinter, in, mit, nach, neben, über, um, unter, vor*

Before introducing the annotation scheme to the reader, we take a look at how traditional approaches classify spatial prepositions. Kaufmann’s proposal (cf. [14]) clearly belongs to this tradition and is the starting point for our analysis.

A. Traditional Classification of Prepositions with Spatial Use

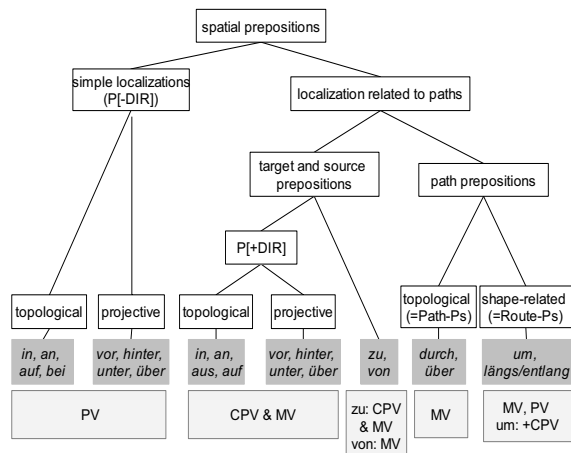


Figure 1. Classification of spatial prepositions (cf. [14])

⁴ Temporal and causal interpretations often go hand in hand, as the cause has to precede the effect temporally.

⁵ We would like to thank an anonymous reviewer for suggesting a formal distinction between multifunctionality and ambiguity. While the scheme does not distinguish between these cases, indicating the distinction through an additional feature could amend the annotation.

Kaufmann offers a classification for ‘spatial prepositions’ that is based on the prepositions’ combinatorial potential with certain verb classes. As the verb classes are differentiated by their combinatorial potential with different types of PPs with a spatial use, the classification is in fact mutually dependent. Three groups can be distinguished among verbs expressing a localization: position verbs (PV) e.g. *stand* or *sit*, causative position verbs (CPV) like *put* or *place*, and motion verbs (MV) e.g. *walk* and *fly*.

The distinction applied to the prepositions is now made between prepositions that encode *simple localizations* in a region and those that describe *localizations related to a path* (cf. Figure 1). The former class is further subdivided with respect to its neighborhood region into topological (*in*, *an*, *auf*, *bei*) and projective (*vor*, *hinter*, *unter*, *über*) prepositions, as it is common in traditional literature. Topological prepositions express relations between objects, while projective prepositions “convey information about the direction in which an object is related to the other” ([15]). The entire simple-localization class is characterized by the fact that these prepositions can combine with position verbs (9), but not denote the target of a motion verb, as can be seen in (10).

- (9) *Er sitzt in/vor dem Café.*
‘He sits in/in front of the café.’
- (10) **Er läuft in/vor dem Café.*
‘He runs in/in front of the café.’ (Café = target)

The second class in Kaufmann’s taxonomy contains prepositions expressing a localization related to a path. This category branches into *target and source prepositions* and *path prepositions*. The first subclass of target and source prepositions is built of the prepositions expressing directionality. This branch is the directional equivalent to the prepositions expressing simple localizations. While prepositions expressing simple localizations govern the dative case, the target and source prepositions govern accusative case. Correspondingly, this class is further differentiated into topological (*in*, *an*, *aus*, *auf*) and projective (*vor*, *hinter*, *unter*, *über*) directional prepositions. The directional prepositions are subsumed here, as they combine with causative position (11) and motion verbs (12). In this, they differ from prepositions expressing simple localizations, which govern dative case, as has been illustrated in (9) and (10).⁶

- (11) *Er stellt die Tasche in/vor das Café.*
‘He puts the bag into/in front of the café.’
- (12) *Er läuft in/vor das Café.*
‘He runs into/to the front of the café.’

The two prepositions *von* and *zu* are not classified as directional. Instead they make up an individual class within the category of target and source prepositions. While this class is justified by the inability of *von* and *zu* to alternate between dative and accusative case, homogeneity of the class cannot be claimed, as *zu* combines with causative position and motion verbs, while *von* only allows motion verbs.

- (13) *Er stellt die Tasche zu dem Tisch.*
‘He puts the bag to the table.’
- (14) *Er läuft zu dem Tisch.*
‘He runs to the table.’
- (15) **Er legt die Tasche von dem Tisch zu der Theke.*
‘He puts the bag from the table to the bar.’
- (16) *Er läuft von dem Tisch zu der Theke.*
‘He runs from the table to the bar.’

The class that remains unexplained yet is that of the path prepositions, comprising path prepositions that are topological (*durch*, *über*), and route prepositions that are shape-related (*um*, *längs/entlang*). The topological path prepositions describe passages and can only be combined with motions verbs (17).

- (17) *Er geht durch das Gebäude.*
‘He goes through the building.’

The prepositions that are shape-related hold the characteristic that they are combinable with position and motion verbs and the preposition *um* is additionally combinable with causative position verbs.

- (18) *Sie sitzen um den Tisch/längs des Tisches.*
‘They sit around/along the table.’
- (19) *Sie laufen um den Tisch/längs des Tisches.*
‘They run around/along the table.’
- (20) *Sie stellen die Stühle um den Tisch/längs des Tisches.*
‘They put the chairs around/along the table.’

A classification like the one discussed in this section could serve as a starting point for an annotation of spatial preposition senses. However, the spatial prepositions classified here do not exactly match the prepositions we are interested in. Also, not every preposition with a spatial interpretation was classified (it does not cover *gegen*, *mit*, and *nach*) and, moreover, not every spatial interpretation of the prepositions classified was taken into consideration (for instance the following spatial subsenses are not covered: a projective sense of *auf* as well as a topological sense of *unter* and *über*⁷). It might be possible to extend the presented classification to reach a more fine grained classification and to add missing senses. With the given arrangement of classifying attributes, we might encounter a proliferate set of features which effectively blocks the feasibility of the scheme for manual annotation.

Our goal is to classify preposition senses with high granularity but with the concomitant aim for the classification to be compact enough to serve the actual intention of manually annotating senses with the help of the classification.

B. Mapping Prepositions to Spatial Senses

Instead of following the traditional view of classifying spatial prepositions, the present scheme classifies spatial senses that are associated with the respective prepositions. Traditional criteria were used to distinguish different senses. A rearrangement enables us to add missing interpretations as well as adding more precise distinctions without inflating the scheme, which is depicted in Figure 2.

⁶ A morphological differentiation between directional and static preposition, like in English (e.g. *in/into*) does not exist in German.

⁷ See section III.D for the illustration of these senses.

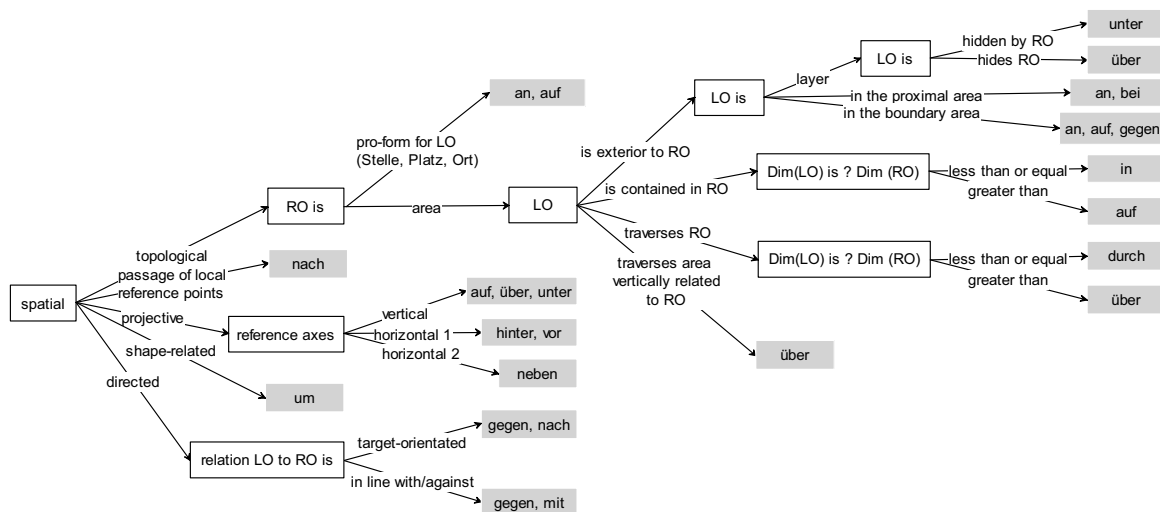


Figure 2. Spatial tree with relations between LO and RO

Many preposition senses can be classified as topological in locating the localized object (LO) in a neighboring region of the reference object (RO). They have to be distinguished from projective preposition senses, which locate the LO with the help of reference axes as well as from shape-related *um*, one special interpretation of *nach* and some directed senses. Topological preposition senses can be split up further into the ones locating the LO in a region inside the RO, the ones locating the LO exterior to the RO, and the ones used for a traversal of the RO by the LO (the transit interpretations). As can be seen in Figure 2, the criteria for identifying the pertinent senses for localizing a LO *within* a RO are identical to the ones for localizing a traversal, except that they map to different prepositions, an issue to which we will return in more detail below.⁸

A feature in the scheme worth explaining is the topological *pro-form for the located object*. It can be traced back to [16], who observed that a concept like *position* (in German realized as *Stelle* or *Platz*) does not refer to a concrete object but functions as some kind of pro-form for local entities. The reference of this concept can only be traced in a concrete situation and with a given context.

The scheme in Figure 2 does not draw an obvious distinction with respect to directionality. The reason is that directionality does not affect the basic criteria for the identification of spatial senses with regard to regions and axes. Two aspects have to be considered here: First, a differentiation between local and directional senses does not apply to every spatial interpretation. Second, as was already pointed out in section A, a case government alternation is correlated with the assignment of directionality. A preposition with a static localization sense typically governs the dative case, while a directional interpretation leads to accusative case government, as is illustrated in (21) and (22).

(21) *Die Katze liegt vor dem Bett.*

The cat lies in front of the bed.DAT
‘The cat lies in front of the bed.’

(22) *Die Katze legt sich vor das Bett.*

The cat lies down in front of the bed.ACC
‘The cat lies down in front of the bed.’

With regard to the first aspect, we note that the preposition *bei* (‘at’, ‘by’, ‘near’), for example, never takes a complement in the accusative⁹ while *über* in its transit interpretation (‘across’) is never followed by a dative¹⁰. Consequently, the feature [±DIR] will be added to a sense after the classification in Figure 2 has been traversed, and is not listed as a separate feature in Figure 2 or Figure 3 below. The assignment is applied automatically if directionality is correlated with a case government alternation; and is set to a fixed value if only one value is possible for a given sense.

In some spatial contexts the preposition *nach* (‘after’/‘behind’) gets a spatial interpretation different from the target-orientated one (‘to’) in (23). There seems to be an interrelation with a temporal interpretation as well as with the projective *hinten* that might be worth investigating further. We call this relation in (24) a ‘passage of local reference points’ cf. [12].

(23) *Die Familie fährt nach Hamburg*

‘The family drives to Hamburg.’

(24) *Nach der Kapelle sind die Hügel zum Greifen nahe.*

‘After/Behind the chapel the hills come within reach.’

We distinguish preposition senses that may receive the feature directional from preposition senses that are directed. Directed preposition senses express an inclination or alignment.

⁹ In most cases the directional counterpart of *bei* is *zu* (‘to’).

¹⁰ One could assume that all usages of *über* are directional. However, examples like the following show that this assumption cannot be maintained:

1) *Sie geht stundenlang über die Wiesen um Blumen zu suchen.*

‘She walks across/over the meadows for hours, searching for flowers.’

⁸ The prepositions in Figure 2 are not part of the decision tree, but are listed for illustrative purposes only.

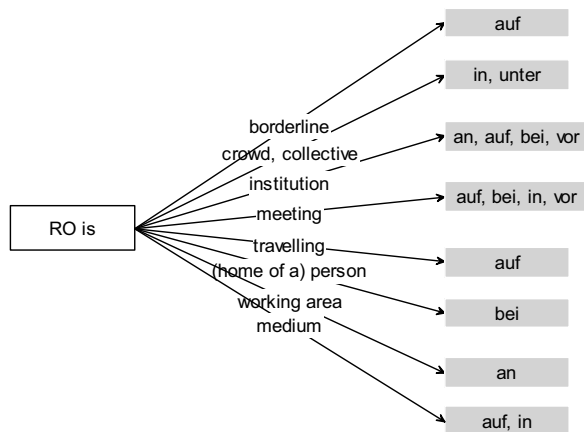


Figure 3. Selectional restrictions on RO

They split up into the target-orientated interpretations of *nach* and *gegen* ('to') ((25), (26)) and the interpretation 'in line with' of *mit* ('with') (27) and its counterpart *gegen* ('against') (28).

(25) *Das Pendel schlug nach der Seite aus.*
'The pendulum swung to the side.'

(26) *Das Pendel schlug gegen eine Seite aus.*
'The pendulum swung to the side.'

(27) *Ernst fotografiert mit dem Licht.*
'Ernst takes a picture with the light.'

(28) *Ernst fotografiert gegen das Licht.*
'Ernst takes a picture against the light.'

Within spatial senses, we distinguish localizations that can be characterized with the help of the relation between LO and RO (Figure 2) from localizations which seem to include selectional restrictions on the syntactic object of the preposition (Figure 3). The latter are typically excluded from systematic classifications of spatial prepositions.

They cannot sufficiently be described by the relation between LO and RO and require additional restrictions. There is still a two-place relation established by the preposition but some additional selectional restrictions on the object of the preposition cause a change of the interpretation. A compositional interpretation is no longer possible.

Take, e.g., the PP *bei seinen Eltern* in (29). The PP does not denote a localization of *Herbert* in the proximal region of his parents, but implies that he is visiting his parents' home, regardless of the parents being there at the same time. Similarly, the PP *am Fließband* does not denote a localization of its external argument in the proximal region of the assembly line but indicates that he is *working* on the assembly line. This interpretation shift is only possible if the object of the preposition meets the relevant restrictions.¹¹

¹¹ Without a context the example (29) is ambiguous between an interpretation in which the LO is localized in proximal region of the RO, and the interpretation adhered to above, and thus would lend itself to multiple annotations, as discussed in section II.

(29) *Herbert ist bei seinen Eltern.*
Herbert is at his parents
'Herbert is at his parents' home.'

(30) *Er steht den ganzen Tag am Fließband.*
He stands the whole day at the assembly line
'He works on the assembly line the whole day.'

In some cases, apparent spatial senses of prepositions could be traced back to prototypical localizations, but have departed to a large degree from these, particularly since the prepositions typically select an internal argument, which is an abstract entity and cannot serve as a spatial reference object. We do not classify such senses as SPATIAL interpretations; instead, the scheme provides other senses, for example ASSIGNMENT that can be assigned to the preposition in those examples.

(31) *Er gab zu, dass der letzte Monat, mit fünfzehn Todesopfern auf israelischer Seite, eine schwere Periode gewesen sei.*
He admitted that the last month with fifteen casualties on Israeli side a difficult period has been
'He admitted that the last month has been a difficult period with fifteen casualties on Israeli side.'

C. Relevant Dimensions; Inside and Through

It may astonish that we assume a sense of *auf* ('on') is classified together with a sense of *in* as localizing the LO within the RO. However, *auf* can be used as an alternative to *in* in cases where the requirements of *in* concerning the dimensions of LO and RO are not fulfilled. *In* requires its internal argument, the RO, to have at least the number of dimensions of the LO. To put it simply, a three-dimensional object does not fit into a two-dimensional one (cf. [17]). One could argue that in those examples *auf* offers a localization in a boundary area of the RO or simply means 'higher than (+contact)'. Such an analysis, however, could not account for the similarity of *auf* and *in* in the examples (32) and (33) nor for the possibility of example (34). In this example the verb *vergraben* ('buried') impedes an interpretation in which the LO is located higher than the RO but only allows for an interpretation of the LO being buried somewhere within the area of the construction site.

(32) *Es befanden sich Schweizer Truppen in deutschem Gebiet.*
'There were Swiss troops in German territory.'

(33) *Es befanden sich Schweizer Truppen auf deutschem Gebiet.*
'There were Swiss troops on German territory.'

(34) *Es lag auf der Baustelle vergraben.*
'It was buried on the construction site.'

Assuming *auf* as an alternative to *in* depending on the dimensions of RO and LO (or the dimensions of their conceptualizations) but with roughly equal semantics also highlights the consistent behavior of the path prepositions *über* and *durch* ('through'). Wherever *auf* is used for a localization inside the RO (35), *über* is used for a traversal (36). Whenever the

requirements of *in* for a localization inside the RO are fulfilled (37), for a traversal its analog *durch* is the right choice (38).

- (35) *Er liegt auf der Wiese.*
'He lies on the lawn.'
- (36) *Er geht über die Wiese.*
'He walks across the lawn.'
- (37) *Er liegt im Wald.*
'He lies in the woods.'
- (38) *Er geht durch den Wald.*
'He walks through the woods.'

D. Topological and Projective Interpretations of Prepositions

Reference [18] uses the combination with spatial measurements like *zwei Meter* ('two meters') to distinguish topological from projective *prepositions*. While we follow [18] in employing spatial measurements as a criterion, we would like to point out that it can only be a criterion to distinguish topological from projective *senses*. Projective senses provide a dimensional vector as a third argument in addition to LO and RO, which can be identified with spatial measurements. For the same reason, they do not find an anchor in topological senses, which do not provide such an argument, as can be witnessed by comparing the *projective* interpretations of *vor* and *hinter* in (39) with the topological interpretations of *bei* and *an* in (40).¹²

- (39) *Zwei Meter vor/hinter dem Tisch*
'Two meters in front of/behind the table'
- (40) **Zwei Meter bei/an dem Tisch*
'Two meters at/near the table'

While (39) and (40) might initially suggest that the distinction hinges on the lexeme, i.e. that *vor* and *hinter* are projective prepositions, but *bei* and *an* are topological, further scrutiny shows that the distinction can indeed be applied to the very same preposition; leading to complex sets of constraints on localizations, as is witnessed for *über* in (41) and (42).

- (41) *Das Bild hängt über dem Loch.*
The picture hangs above the hole
'The picture hides the hole.'
- (42) *Das Bild hängt zwei Meter über dem Loch.*
'The picture hangs two meters above the hole.'

The interpretation of *über* changes depending on the presence of a measurement. In the first sentences the hole is (partially) hidden by the picture while in the second one the picture is located two meters above the hole. The second one is a projective use of the preposition while the first interpretation is not. An arrangement in layers is relevant here instead, and *über* systematically interchanges with *unter* depending on one layer hiding the other (41) or being hidden by it (43).

- (43) *Das Loch ist unter dem Bild.*
'The hole is hidden by the picture.'

¹² It should be noted, though, that the kind of measurement has to be taken into consideration. Topological prepositions are not illicit with all spatial measurements but only with numeral classifiers.

- 2) *Nahe bei/an dem Tisch*
'Near by the table'

In addition to the aforementioned interpretations the preposition *über* shows an interpretation referring to a traversal of an area vertically related to the RO.¹³

- (44) *Er springt über die Mauer.*
'He jumps over the wall.'

We do not assume this interpretation to be projective because in combination with a measurement it is not the height that is measured but the distance of the goal from the RO or even the space crossed by the jump.¹⁴

- (45) *Er springt 2m über die Mauer.*
'He jumps across the wall and lands 2m behind it.'

Conclusively it is not sufficient to say that *über* is a projective preposition but that *über* has one interpretation which is projective (this might be the more prominent one, but it cannot be denied that the other interpretations exist).

Just as well, it is not satisfying to assume that *auf* is a topological preposition. There are topological interpretations of *auf*, like in (46), where no relevant directional vector or axis can be detected.

- (46) *Die Schrift auf dem Schild*
'The lettering on the sign'

But to increase the complexity, *auf* installs some restrictions concerning contact or support between the LO and RO (e.g. [19], [12]). These preclude the use of measurements defining a distance as a test for projective interpretations. From the impossibility of (48) one cannot conclude that *auf* is not projective but could argue that it is *auf*'s demand for contact that forbids measurements.

- (47) *Die Tasse steht auf dem Tisch.*
'The cup stands on the table.'
- (48) **Die Tasse steht zwei Meter auf dem Tisch.*
'The cup stands two meters on the table.'

Intuitively, an interpretation of sentences like (47) involves the vertical axis. Building the opposite with *unter* ('under'), *auf* behaves like *über* with its projective interpretation and we suggest assuming a projective interpretation of *auf*.

IV. SUMMARY

We presented a new classification for spatial interpretations of German prepositions that is part of a more comprehensive annotation scheme for (an excerpt of) German prepositions.

In the classification we consider prototypical spatial senses as well as some functional derivations of these senses that can be defined by means of characteristics of the internal object of the prepositions.

¹³ In these cases the RO has to have an extension on the vertical axis.

¹⁴ Verbs of motion offer the possibility to measure the length of the path, irrespective the direction of the movement. But with projective prepositions there should be an interpretation present that measures the actual distance on the relevant axis.

- 3) *Er geht drei Meter hinter den Baum.*
≈He walks three meters (altogether) and stops somewhere behind the tree.
≈He walks and stops three meters behind the tree.

Instead of assigning defining attributes to a lemma of a preposition we recommend a careful distinction between the different interpretations of that preposition. As we have evidenced, an interfusing of different interpretations results in an incomplete picture of spatial prepositions.

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