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Abstraction and Underspecification in Semantic Transfer

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Abstract

This paper introduces the semantic transfer approach MinT (Minimal Transfer) that has been developed in the speech-to-speech MT system VERBMOBIL. As a unification-based and lexicalist semantic transfer model, it relies on some central ideas of the MRS-based transfer approach outlined in [Copestake et al., 1995]. It differs, however, from the latter in certain aspects: in MinT, the idea of *abstraction* and *underspecification* is worked out in much more detail and has been applied to a variety of translation phenomena. MinT relates SL and TL semantic descriptions on a maximally abstract level, which results in simultaneously decreasing the number of transfer rules and leaving a considerable amount of options for lexicalization and grammaticalization up to the generator. To preserve ambiguities that hold across the involved languages MinT processes underspecified semantic representations.

1 Introduction

In this paper, we present the semantic transfer approach MinT (Minimal Transfer) that has been developed for the face-to-face MT system *Verbmobil* and is applied to the German-English transfer part. *Verbmobil* is designed to produce English output for spoken German and Japanese input in the domain of appointment scheduling dialogs.

The input for the MinT module are UMRS (Underspecified Minimal Recursion Semantics) structures (see section 3) which are the result of the syntactic and semantic analysis. On the basis of these semantic representations (SR), an evaluation component provides information about the dialog context and the speech acts by integrating domain-specific world knowledge. It allows the transfer and other components to access additional information. The transfer provides the generator with target UMRS representations, which are mapped to TL expressions and transformed into speech by the synthesis component.

The central idea of MinT ([Abb and Buschbeck-Wolf, 1995]) is to relate underspecified SL and TL semantic descriptions on a level with a maximal degree of abstractness so that analysis and transfer efforts can be reduced significantly. MinT is a semantic, unification-based and lexicalist transfer model that is based on some central ideas of the MRS-based approach outlined in [Copestake et al., 1995] and the Shake-and-Bake approach to MT sketched in [Whitelock, 1992]. But it differs from them in certain aspects: in MinT, the idea of abstraction and underspecification is worked out in much more detail and has been applied to a variety of translational phenomena. MinT involves techniques for the resolution of translational ambiguities and copes with structural-semantic divergences in a systematic way.

This paper is organized as follows: in section 2, we briefly discuss the utility of abstraction and underspecification in MT. Section 3 introduces the framework of UMRS with focus on underspecified representations. In section 4, we describe the MinT approach and give some technical details. In section 5, we illustrate the main ideas of MinT with a series of examples. Section 6 summarizes the most important features of MinT.

2 Abstraction and Underspecification in MT

The interlingua-based approach to MT (IL) is known to have various advantages, most notably language pair independence ([Hutchins and Somers, 1992]). However, although there is a set of universal concepts that has proved to be useful for interlingual MT, the idea that translations always share the same IL representation is problematic because of translation mismatches, i.e. cases where the languages involved cannot be mapped onto a language-neutral representation ([Kameyama et al., 1991], [Kay et al., 1994]), and cases where two languages do not share the same logical structure. To avoid these difficulties, we adopt a semantic transfer approach.

Abstracting away from morphosyntactic realizations and leaving unresolved ambiguities that hold across languages, semantic transfer seems to be the most reasonable tradeoff between the traditional transfer and IL approach (see also [Copestake, 1995]). Moreover, IL mappings can be employed whenever possible, which lowers the costs of the involvement of new languages.

In MinT, we make extensive use of abstraction (see section 5) in order to raise the mapping level w.r.t. the Vauquois Triangle ([Vauquois, 1975]) as high as possible. By the use of predicates that abstract away from the concrete lexicalization or grammaticalization, we approach partial language-neutral representations that allow the generator to produce alternative translations, given that it receives reasonable restrictions for different word options. Abstraction also leads to a reduction of the redundance of transfer statements to the necessary minimum.

In order to avoid expensive resolution procedures, it is most desirable to preserve ambiguities that hold within a language pair ([Alshawi et al., 1991], [Kay et al., 1994]). Considering the language pair German-English, these are first of all scope ambiguities ([Reyle, 1993]) and modifier attachment ambiguities ([Egg and Lebeth, 1995]). At the lexical level, most ambiguities have to be resolved for translation ([Hutchins and Somers, 1992]), although very few of them hold across languages, e.g. polysemy ([Copestake and Briscoe, 1995]) and vagueness in meaning relations between the constituents of compounds. Given the concrete dialog situation, other ambiguities, such as anaphoric and deictic references or information structuring, can often be kept unresolved because speaker and hearer in general share the same situation and world knowledge.

The core feature of the UMRS formalism is that it allows for these types of underspecifiation (see section 3). The MinT formalism supports the mapping of underspecified semantic representations. Thus, combining the notions of abstraction and underspecification, we achieve a maximally abstract transfer mapping.

3 Introduction to UMRS

MinT is linked up with Underspecified MRS ([Egg and Lebeth, 1995]), which grew out of Minimal Recursion Semantics (MRS) ([Copestake et al., 1995]). UMRS is a semantic formalism for HPSG that provides underspecified representations for operator scope and modifier attachment ambiguities.

Semantic predicates are represented as feature structures (FS) of the type *relation* that introduce features for instances (INST) and roles (ARG) ([Pollard and Sag, 1994]).[1] The use of types for semantic predicates allows for inferring semantic properties from the type hierarchy, e.g. aspectual properties of verbs, for representing lexical ambiguities, e.g. the affiliation of a lemma to several semantic classes, as well as for representing underspecified relations, e.g. the kind of meaning relation (thematic, possessive, part-of, etc.) between nouns, such as compounds and genitive constructions.

The values of instances and roles are sorted w.r.t. a type hierarchy of semantic sorts in order to specify selectional restrictions in the grammar and to enable disambiguation in the transfer module. Moreover, sorts can be used to express lexical underspecification, e.g. for the representation of polysemy that holds across languages.[2]

In UMRS, an SR is defined as a set-valued conjunction of predicates represented as a flat list of relation types. The sentence in (1), for example, is assigned the SR in (2).[3]

(1) Morgens mache ich nie Termine aus.
    ('In the morning I never arrange appointments.')

[1] For the sake of simplicity, we circumscribe the interpretation of ARG1, ARG2 and ARG3 as being associated with agenthood, experiencerhood and themehood, respectively.

[2] The sortal ambiguity of systematically polysemous nouns is expressed by disjunctive types. For example, the INST of *university* is assigned the sort *inst_loc_coll* (defined as the disjunction of *institution, building* and *collective*) that leaves the specification of the institutional, spatial or staff reading underspecified. If necessary for specific transfer tasks, the disjunctive sort can be refined.

[3] For better readability, sorts as well as tense and mood information are omitted. Tags are marked with a prefix, i.e. *i* corresponds to the instance (i.e. the value of the attribute INST) and *h* to the handel.

(2)

$$\left\langle \begin{bmatrix} \mathit{decl} & \\ \text{HD} & \boxed{h1} \\ \text{HD\_ARG} & \boxed{h2} \end{bmatrix}, \begin{bmatrix} \mathit{nie} & \\ \text{HD} & \boxed{h2} \\ \text{INST} & \boxed{i2} \\ \text{HD\_ARG} & \boxed{h4} \end{bmatrix}, \begin{bmatrix} \mathit{morgens} & \\ \text{HD} & \boxed{h3} \\ \text{INST} & \boxed{i3} \\ \text{PAIRS} & \left\langle \begin{array}{l} \left\langle \boxed{h4}, \boxed{i4} \right\rangle \\ \left\langle \boxed{h6}, \boxed{i6} \right\rangle \end{array} \right\rangle \end{bmatrix}, \begin{bmatrix} \mathit{ausmachen} & \\ \text{HD} & \boxed{h4} \\ \text{INST} & \boxed{i4} \\ \text{ARG1} & \boxed{i5} \\ \text{ARG3} & \boxed{i6} \end{bmatrix}, \begin{bmatrix} \mathit{pron} & \\ \text{HD} & \boxed{h5} \\ \text{INST} & \boxed{i5} \end{bmatrix}, \begin{bmatrix} \mathit{termin} & \\ \text{HD} & \boxed{h6} \\ \text{INST} & \boxed{i6} \end{bmatrix} \right\rangle$$

All elements of an SR list are addressed via a value of a specific attribute, called handel (HD). In addition, scope-bearing relations have a feature HD_ARG for representing the embedding of other relations by pointing to the highest handel of the embedded set of relations. In (2), for example, the HD_ARG of the sentence mood *decl* (declarative) is coindexed with the handel of the operator *nie* ('never') the HD_ARG of which embeds the handel of *ausmachen* ('arrange'). Intersective modification is expressed by coindexation of the handels and instances of all elements of a modification structure. In an unambiguous representation, all handels are part of a unique handel chain.

The connection between a scope-bearing relation and its scope domain or between a modifier and its modified elements can be kept underspecified by leaving the respective coindexations uninstantiated and storing the range of reasonable HD/INST values as a list of disjunctions, i.e. an operator relation stores the possible elements of its scope domain and a modifier its possible attachment sites. In the SR (2), for instance, the temporal adverb *morgens* ('in the morning') has two possible attachment sites, which are stored in the attribute PAIRS. It modifies either *Termine* ('appointments') or *ausmachen* ('arrange'). Thus, an ambiguous representation bears a number of fragments of functor-argument chains that can be chained together in a subsequent resolution process, if required for a specific translation task ([Lebeth and Schilder, 1996]). In case the ambiguity holds across languages, the underspecified representation is handed over to the generator.

4 The Architecture of MinT

In the MinT system, we have strictly separated the declarative knowledge bases, i.e. the language-specific predicate hierarchies, the sort hierarchy and the data base of transfer correspondences (TCs), from the processing environment. MinT is designed as a two-level transfer with a monolingual and a bilingual subprocessor, with both levels operating on their specific set of TCs.

4.1 Transfer correspondences

In accordance with [Copestake et al., 1995], bilingual TCs establish the equivalence between sets of source and target UMRS relations. In contrast, monolingual TCs provide a solution to divergences in the logical structure of the languages involved. The idea is to allow the transfer component to initiate further composition and refinement processes (see also section 5.2) if this is motivated by the contrastive data. Monolingual TCs are mappings within the SL, i.e. mappings of sets of SL UMRS relations to sets of SL UMRS relations.[4]

TCs are optionally provided with a condition part that serves to restrict the range of their application to the relevant context. The condition list might contain sets of SL relations to fix the semantic context as well as extralinguistic information, such as the current dialog act. Let us illustrate with (3) how **bilingual TCs** work:

(3a) Das ist ein *kurzfristiger* Termin.
This is a *quick* appointment.

(3b) Wir vereinbaren diesen Termin *kurzfristig.*
We'll arrange this appointment *at short notice.*

(3c) Der Termin ist mir zu *kurzfristig.*
This appointment is too *soon* for me.

(3) shows that the translation of *kurzfristig* depends on whether it is used as an adjectival modifier (3a), an adverbial modifier (3b) or as predicative of the copula (3c). Since in UMRS intersective adjectives, intersective adverbs and predicatives share the same SR ([Abb and Maienborn, 1994]),[5] the particular usage has to be recovered in the TC. In (4) and (5) this is achieved by specifing the type of the modifier (i.e. *noun* and *verb*). In (6), the condition part fixes the predicative use which is represented by coindexing the instance of the copula's subject and its predicative. The predicative is embedded by the copula's semantics, i.e. the support relation, via its HD_ARG.

(4) $$\left\langle \begin{bmatrix} \textit{kurzfristig} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \end{bmatrix} \right\rangle, \left\langle \begin{bmatrix} \textit{noun} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \end{bmatrix} \right\rangle \Leftrightarrow \left\langle \begin{bmatrix} \textit{quick} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \end{bmatrix} \right\rangle$$

[4] The mapping operator for monolingual TCs is "$\Rightarrow$", and "$\Leftrightarrow$" for bilingual TCs.

[5] By leaving the syntactic categorization underspecified we gain more freedom for the generation and more efficiency in transfer, since the adjective/adverb/predicative distinction is not decisive for the majority of transfer tasks.

(5)
$$\left\langle \begin{bmatrix} \textit{kurzfristig} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \end{bmatrix} \right\rangle, \left\langle \begin{bmatrix} \textit{verb} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \end{bmatrix} \right\rangle \Leftrightarrow \left\langle \begin{bmatrix} \textit{at} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{INT\_ARG} & \boxed{i2} \end{bmatrix}, \begin{bmatrix} \textit{short} & \\ \text{HD} & \boxed{h2} \\ \text{INST} & \boxed{i2} \end{bmatrix}, \begin{bmatrix} \textit{notice} & \\ \text{HD} & \boxed{h2} \\ \text{INST} & \boxed{i2} \end{bmatrix} \right\rangle$$

(6)
$$\left\langle \begin{bmatrix} \textit{kurzfristig} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \end{bmatrix} \right\rangle, \left\langle \begin{bmatrix} \textit{support} & \\ \text{HD} & \boxed{h2} \\ \text{INST} & \boxed{i2} \\ \text{HD\_ARG} & \boxed{h1} \end{bmatrix} \right\rangle \Leftrightarrow \left\langle \begin{bmatrix} \textit{soon} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \end{bmatrix} \right\rangle$$

As a second type of TC, **monolingual TCs** are used to adjust the source FS in such a way that systematic divergences in the semantic representation for a language pair can be bridged. For example, languages may differ w.r.t. whether they allow a verbal or predicative construction with a particular class of adverbs:

(7a) Er *äußerte* sich kritisch/verächtlich.
(7b) *He *expressed/uttered* himself critically/disparagingly.
(7c) He *was* critical/disparaging.

(7) illustrates a case of category switching that is treated by the monolingual TC in (8). It states that if *äussern* is modified by an adverb of the type *opinion_adv* then this set of relations is substituted by the support relation with the adverb embedded as the predicative. The ARG1 value of *äussern* has to be coindexed with the instance of the adverb in predicative use while the copula acts as the new anchor for the situation's instance.

(8)
$$\left\langle \begin{bmatrix} \textit{äußern} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG1} & \boxed{i2} \end{bmatrix}, \begin{bmatrix} \textit{opinion\_adv} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \end{bmatrix} \right\rangle \Rightarrow \left\langle \begin{bmatrix} \textit{support} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{HD\_ARG} & \boxed{h2} \end{bmatrix}, \begin{bmatrix} \textit{opinion\_adv} & \\ \text{HD} & \boxed{h2} \\ \text{INST} & \boxed{i2} \end{bmatrix} \right\rangle$$

Here, the source SR is reorganized within the SL before it is passed to the bilingual component. This is favorable in order to capture the generalization over the whole class of *opinion_adv*. Otherwise, one would need one bilingual TC for each of these adverbs.

Furthermore, we assume that the monolingual component refines particular ambiguous predicates before the actual bilingual transfer, since it is often required to have predicates disambiguated before other transfer operations can start. We will address this problem in section 5.2.

4.2 The procedural environment

The MinT system has been implemented and tested for a representative part of the *Verbmobil* dialogs. The data base, i.e. the TCs and the type and sort hierarchies, are specified in CUF ([Dörre et al., 1994]). TCs are statically compiled to more efficient Prolog goals with an abstract data type interface to CUF-internal data structures. The MinT processor takes a list of FS of the type *relation* as input and processes it in two steps: in the monolingual stage, the SL list is transformed into a (perhaps) refined and adjusted SL list. The transformed SL list forms the input to the subsequent bilingual processing step where the TL list is built up.

The selection strategy of the transfer processor for competing TCs is guided by two heuristics (ordered w.r.t. importance):

1. TCs with a more complex SL *predicate* part are chosen first.
2. TCs with a more complex SL *condition* part are chosen first.

Thus, an unconditioned n-to-m TC with $n > 1$ is preferred to a conditioned 1-to-n TC even if the total complexity of the 1-to-n TC is higher.

4.3 Modelling transfer correspondences as typed features structures

After having sketched how UMRS-based transfer works, we want to underline our decision to utilize unification as the basic transfer operation. There are at least three major points in favor of using typed feature structures for transfer: first, the reference to higher types in the TCs allows the generalization of the mapping of predicates that fall into the same semantic class w.r.t. a specific property (see section 5.1). This strategy minimizes both the amount of transfer rules and the expense of transfer operations. Second, UMRS-based transfer allows for a combination of the transfer and the IL approach (see section 2). Coindexation of FS can be seen as the interlingual part in UMRS-based transfer, i.e. a simple mechanism to preserve the bilingual parts of an SR in the TL that is used to pass cross-linguistically invariant semantic categories, such as referential information, directly to the generator. Third, type subsumption can be employed to map language-specific predicates to more abstract ones thus allowing for a broader range of target lexicalizations.

5 Examples

In this section, we will demonstrate the main ideas of MinT with some examples. In section 5.1, we introduce bilingual predicate types for utterances that express attitudes and show their mapping. In section 5.2, we give an example for the refinement in the monolingual part of MinT, and in section 5.3, we present various transfer mappings that involve abstract predicate types.

5.1 Abstraction by bilingual predicate types

With the traditional strategy of relating SL-specific predicates directly to TL-specific predicates, generation loses any freedom in lexical choice. This results in a restricted and monotonous translation. However, one often can identify a variety of words that fit the meaning of a predicate. Hence, it is reasonable to introduce abstract types in the SL and TL relation hierarchies that bundle various predicates that are synonymous w.r.t. the considered domain. The incoming predicate must be subsumed by the more abstract type in the TC, i.e. it ignores the specificity of the incoming predicate and instead transmits the abstract predicate to the generator. The subtypes of this abstract type specify the range of possible lexicalizations in SL and TL. Let us exemplify this with attitude verbs and attitude adverbs.

(9a) Der Montag *paßt* bei mir / *geht* bei mir / *klappt* bei mir.
(9b) Monday *suits* me / *works* for me.

To express that something suits somebody, German and English offer different verbs, such as in (9), which leads us to introduce the bilingual type *abstr_suit* in the SL and the TL relation hierarchies (10).[6] (11) presents the TC for the abstract predicate *abstr_suit* that covers the examples in (9).

(10)
```
abstr_suit = passen | klappen | gehen.
abstr_suit = suit | work.
```

[6] In CUF the symbol "=" specifies the relation between a type and its subtypes. Disjointness and exhaustivity are expressed by the symbol "|".

(11)
$$\left\langle \begin{bmatrix} \textit{abstr\_suit} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG}3 & \boxed{i2} \end{bmatrix} \right\rangle \Leftrightarrow \left\langle \begin{bmatrix} \textit{abstr\_suit} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG}3 & \boxed{i2} \end{bmatrix} \right\rangle$$

(12) exemplifies some attitude-expressing adverbs that correspond to each other as a whole class.

(12a) Montag ist *gut/angenehm/schön/okay* (bei mir/für mich).
(12b) Monday is *good/convenient/fine/okay/all right* (for me).

(13) presents the language-independent upper partition of attitude-expressing adverbs that is assumed for the considered domain.

(13)
```
attitude_adv = pos_attit_adv | neg_attit_adv.
 pos_attit_adv = neutral_pos_attit_adv | extreme_pos_attit_adv.
 neg_attit_adv = neutral_neg_attit_adv | extreme_neg_attit_adv.
```

(14) show the definitions of the bilingual type *neutral positive attitude* in the SL and TL hierarchies.

(14)
```
neutral_pos_attit_adv = gut | angenehm | schön | okay.
neutral_pos_attit_adv = good | convenient | fine | okay | alright.
```

The mapping of types of attitude adverbs is allowed only in particular contexts, since they are only synonymous if they describe the speaker's attitude towards a proposed time or event. Therefore, the TC in (15), which captures the examples in (12), is restricted such that the abstract adverbial predicate is the predicative of the copula and its instance is constrained to the sort *temporal* which subsumes times and events.[7]

(15)
$$\left\langle \begin{bmatrix} \textit{neutral\_pos\_attit\_adv} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1}\ \textit{temporal} \end{bmatrix} \right\rangle, \left\langle \begin{bmatrix} \textit{support} & \\ \text{HD} & \boxed{h2} \\ \text{INST} & \boxed{i2} \\ \text{HD\_ARG} & \boxed{h1} \end{bmatrix} \right\rangle \Leftrightarrow \left\langle \begin{bmatrix} \textit{neutral\_pos\_attit\_adv} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \end{bmatrix} \right\rangle$$

[7] If the theme is expressed anaphorically, the anaphora resolution instantiates the sort of the antecedent.

5.2 Refinement in the monolingual component

To motivate the necessity of an additional refinement step in the monolingual component, let us regard the treatment of prepositions (see section 4.1). As assumed in [Buschbeck-Wolf and Nübel, 1995], ambiguous prepositions are mapped onto abstract meaning relations that can be seen as bilingual concepts from which the TL preposition is generated. These relations are organized in a type hierarchy such that the information about prepositional meanings can be used for further disambiguation in the bilingual module (see section 5.3).

We show the refinement procedure using as an example the German preposition *bei*. In most cases, sortal constraints on its internal argument are sufficient to identifiy the intended meaning.[8] However, if this argument refers to a human being and the situation modified by the PP is an attitude, we are faced with an ambiguity between the perspective reading (16) and the unspecified spatial interpretation (17) of the *bei*-PP.

(16) Geht/klappt das *bei Ihnen*?
(16a) Does it suit *you*?
(16b) Is it possible *at your place*?

(17) Das ist schlecht/ungünstig/unmöglich *bei mir*.
(17a) That is bad/inconvenient/impossible *for me*.
(17b) It is bad/inconvenient/impossible *at my place*.

The scope of this kind of ambiguity can be narrowed down further. If the attitude is related to a time, the spatial interpretation of the *bei*-PP is impossible[9] because times – in contrast to events and things – cannot be located in space. Therefore, we provide the refinement rule in (18) where the sortal constraint *time* on the ARG3 of an attitude verb and on the INST of an attitude adverb forces the perspective reading.[10]

[8] For example, a pure spatial reading of *bei* can be identified if the internal argument refers to a thing or location (e.g. *bei* Berlin - *near* Berlin), and a temporal-spatial one if it is a situation (e.g. *bei* der Vorlesung - *at* the lecture).

[9] E.g. (i) Geht Montag *bei Ihnen*?
*Is Monday possible *at your place*?
(ii) Montag ist schlecht/ungünstig/unmöglich *bei mir*.
*Monday is bad/inconvenient/impossible *at my place*.

[10] Disjunctions of FS (";") are not part of the CUF formalism. They are treated by the transfer compiler.

(18)
$$\left\langle \begin{bmatrix} \textit{bei} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG3} & \boxed{i2}\ \textit{human} \end{bmatrix} \right\rangle, \left\langle \begin{bmatrix} \textit{abstr\_suit} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG3} & \boxed{i3}\ \textit{time} \end{bmatrix} ; \left(\begin{bmatrix} \textit{support} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{HD\_ARG} & \boxed{h2} \end{bmatrix}, \begin{bmatrix} \textit{attitude\_adv} & \\ \text{HD} & \boxed{h2} \\ \text{INST} & \boxed{i3}\ \textit{time} \end{bmatrix} \right) \right\rangle$$
$$\Rightarrow \left\langle \begin{bmatrix} \textit{perspective} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG3} & \boxed{i2} \end{bmatrix} \right\rangle$$

Let us go back to the examples in (16) and (17). Here, the theme of the attitude verb is realized by event type pronouns. Since the antecedent is a situation, the ambiguity of the *bei*-PP cannot be resolved even by anaphora resolution. To figure out which reading is intended, we use information from the dialog module which provides a dialog act for each utterance ([Jekat et al., 1995]). If the *bei*-PP in the considered context form part of an utterance in which a location is negotiated, we can heuristically derive that the spatial interpretation of *bei* is the appropriate one. (19) shows the corresponding refinement rule which includes the verification of the dialog act *location_da*.[11] A further rule with the negated type $\neg$*location_da* maps *bei* to *perspective*.

(19)
$$\left\langle \begin{bmatrix} \textit{bei} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG3} & \boxed{i2}\ \textit{human} \end{bmatrix} \right\rangle, \left\langle \begin{bmatrix} \textit{abstr\_suit} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG3} & \boxed{i3}\ \neg\ \textit{time} \end{bmatrix} ; \left(\begin{bmatrix} \textit{support} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{HD\_ARG} & \boxed{h2} \end{bmatrix}, \begin{bmatrix} \textit{attitude\_adv} & \\ \text{HD} & \boxed{h2} \\ \text{INST} & \boxed{i3}\ \neg\textit{time} \end{bmatrix} \right), \right.$$
$$\left. \begin{bmatrix} \text{HD} & \boxed{h3} \\ \text{D\_ACT} & \textit{location\_da} \end{bmatrix} \right\rangle \Rightarrow \left\langle \begin{bmatrix} \textit{unspec\_spatial} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG3} & \boxed{i2} \end{bmatrix} \right\rangle$$

[11]The dialog act type *location_da* (addressed by the highest handel of the utterance) describes all dialog acts of which the topic is a location. It abstracts away from the concrete dialog act, since for this particular purpose it is not relevant whether a location is requested, suggested, accepted etc.

5.3 Transfer mapping in the bilingual component

In this section, we demonstrate the use of abstract types for more complex TCs using a case of *semantic restructuring* (20), a case of *incorporation* (22), and a case of *head switching* (25).

(20a) Das paßt/geht/klappt *schlecht* (bei mir).
(20b) That does *not* suit me/work *well* (for me).

(21)
$$\left\langle \begin{bmatrix} \textit{schlecht} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \end{bmatrix} \right\rangle, \left\langle \begin{bmatrix} \textit{abstr\_suit} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG3} & \boxed{i2} \end{bmatrix} \right\rangle \Leftrightarrow \left\langle \begin{bmatrix} \textit{neg} & \\ \text{HD} & \boxed{h3} \\ \text{INST} & \boxed{i3} \\ \text{HD\_ARG} & \boxed{h1} \end{bmatrix}, \begin{bmatrix} \textit{good} & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \end{bmatrix} \right\rangle$$

(20) exemplifies a problem with the translation of the predicate *schlecht* in the event that it modifies verbs expressing a positive attitude. In English, negative attitude adverbs cannot be combined with these kinds of verbs. Hence, *schlecht* has to be mapped on its TL antonym *good* and the attitude verb has to be put under the scope of the negation (see ((21)).[12] For this mapping, the modified relation is represented by the abstract type *abstr_suit* in the condition part to restrict the mapping to the relevant context and to anchor the scope of the negation to the right place, viz., the situation handel.[13]

Let us consider a case of incorporation as a further example (22). The preferred way to express in English that something suits someone better is to say that he or she *prefers* it.

(22a) Dienstag würde bei mir/für mich *besser passen/klappen/gehen.*
(22b) I would *prefer* Tuesday.

The TC in (23) shows the mapping of a complex German predicate list to the English verb *prefer*. In UMRS, comparatives are decomposed into a comparative

[12] Due to limitations of space, we dispense with a detailed discussion on how the introduced negation operator is linked to the underspecified scope representation. In short, the PAIRS list (see section 3) of the corresponding scope domain must be updated by adding to it the negation's HANDEL/INST values.

[13] In contrast to our analysis, [Copestake et al., 1995] propose an unrestricted TC that relates *schlecht* to *not good*, the negation having scope over the adjective, and not over the attitude adverb. They regard the choice between *bad* and *not good* as a generation problem which should be solved by TL cooccurence restrictions.

relation *comp* and the adjective's positive form, in our case *gut*. In (23), the comparative *besser* as well as the *bei*-PP modify the attitude verb of the type *abstr_suit*. Both prepositions *bei* and *für* have already been assigned the *perspective* interpretation in the monolingual component (see section 5.2), otherwise this mapping would not be feasible. Note, that the use of the type *abstr_suit* in (23) avoids the multiplication of the rule for each attitude verb.

(23)

$$\left\langle \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{abstr\_suit}} \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG3} & \boxed{i2} \end{array}\right], \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{comp}} \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{HD\_ARG} & \boxed{h2} \end{array}\right], \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{gut}} \\ \text{HD} & \boxed{h2} \\ \text{INST} & \boxed{i1} \end{array}\right], \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{perspective}} \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG3} & \boxed{i4}\ \textit{human} \end{array}\right] \right\rangle \Leftrightarrow \left\langle \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{prefer}} \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG1} & \boxed{i4} \\ \text{ARG3} & \boxed{i2} \end{array}\right] \right\rangle$$

Finally, let us regard a case of head switching (24).

(24) Ich würde Sie *lieber* morgen treffen.
I would *prefer* to see you tomorrow.

Here, the meaning of the German modifier *lieber* - the comparative of *lieb* ('good') - corresponds to the English modality state of *preferring*. This is shown in (25). *Prefer* is a control verb which embeds the situation modified by *lieber* in the SL as its ARG3. The idea is to abstract away from the concrete situation by anchoring the underspecified *situation* type in the TC's condition part. The situation's ARG1 is coindexed with the highest argument of *prefer* as it is expected in the case of subject control. The concrete values of the *tense* and *mood* types are handed over from the German verb's instance to the instance of *prefer*.

(25)

$$\left\langle \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{comp}} \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{HD\_ARG} & \boxed{h2} \end{array}\right], \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{lieb}} \\ \text{HD} & \boxed{h2} \\ \text{INST} & \boxed{i1} \end{array}\right], \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{tense\_mood}} \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{TENSE} & \boxed{d1} \\ \text{MOOD} & \boxed{d2} \end{array}\right] \right\rangle, \left\langle \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{situation}} \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG1} & \boxed{i2} \end{array}\right] \right\rangle$$

$$\Leftrightarrow \left\langle \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{prefer}} \\ \text{HD} & \boxed{h3} \\ \text{INST} & \boxed{i3} \\ \text{ARG1} & \boxed{i2} \\ \text{ARG3} & \boxed{h1} \end{array}\right], \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{tense\_mood}} \\ \text{HD} & \boxed{h3} \\ \text{INST} & \boxed{i3} \\ \text{TENSE} & \boxed{d1} \\ \text{MOOD} & \boxed{d2} \end{array}\right] \right\rangle$$

6 Conclusion and Outlook

We have presented a semantic transfer approach that relies on the use of unification as the basic transfer operation. It allows for the implementation of the idea of abstraction and underspecification in a natural and elegant way. The use of underspecified representations as well as the employment of abstract predicates minimizes both the amount of transfer rules and the expense of transfer operations.

Future research concerns the question of how the idea of abstraction can be optimized. The preprocessing facilities of the monolingual component can be extended to transfer an UMRS representation into a more conceptual-like representation. This representation should abstract away from structural differences in the semantic representation of synonymous expressions that in fact reflect grammatical concepts, such as verbalization and the corresponding predicative constructions (see section 5.1). We also assume abstractions on the lexico-conceptual level, such as a common representation of graduals and their graduated properties.

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