Semantic Transfer in Speech-to-Speech MT

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Abstract

This paper describes a semantic transfer approach called MinT (Minimal Transfer) that has been developed in the speech-to-speech MT system VERBMOBIL. Being 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, without falling back into the well-known problems of the Interlingua approach. This 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 languages involved MinT processes underspecified semantic representations.

Semantic Transfer in Speech-to-Speech MT

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.[1] VERBMOBIL is designed to produce English output for spoken German and Japanese input in the domain of appointment scheduling dialogs.
The input to the MinT module are UMRS (Underspecified Minimal Recursion Semantics) structures, which are the result of the syntactic and semantic analysis of the spoken language input. On the basis of the 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 semantic component, the transfer module and the generator to access additional knowledge. The transfer module provides the generator with target UMRS representations which are underspecified with respect to grammaticalization and lexicalization. The generator maps the TL semantics on lexical and grammatical expressions that are transformed into speech by the synthesis component.
The central idea of MinT[2] is to relate underspecified SL and TL semantic descriptions on a level with a maximal degree of abstractness, so that the 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 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 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. In section 5 we illustrate the main ideas of MinT with a series of examples and, in section 6, we give some technical details of our transfer formalism. Finally, section 7 summarizes the most important features of MinT.

2 Abstraction and Underspecification in MT

The interlingua (IL) approach to MT is known to have various advantages, most notably the language pair independence ([Hutchins and Somers, 1992]). However, although there is a set of universal concepts that proved to be useful for interlingual MT, the idea that translations always share the same IL representation is unrealistic 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 ([Dorr, 1994]). 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 classical transfer und IL approach (see also [Copestake, 1995]). Moreover, IL mappings can be employed where possible, so that the costs of the involvement of new languages becomes justifiable and problems of

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[2] For a more detailed discussion of this approach, see [Abb and Buschbeck-Wolf, 1995].

defining an IL concept for cases of translation mismatches can be circumvented by way of specifying a particular kind of transfer rules, cf. [Abb and Buschbeck-Wolf, 1995]).
In MinT we make extensive use of abstraction, cf. 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 lexicalizations or grammaticalizations 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, some of them hold across languages, e.g. polysemy ([Nunberg, 1979]) 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, cf. section 3. The MinT formalism supports the mapping of underspecified semantic representations and guides the desambiguation on demand.
Thus, combining the notions of abstraction and underspecification we achieve a maximally abstract transfer mapping with a minimum of analysis effort.

3 Underspecified Minimal Recursion Semantics (UMRS)

MinT is linked with so called Underspecified MRS ([Egg and Lebeth, 1995]), which is an extended and modified version 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) (cf. [Pollard and Sag, 1994]).[3]
The use of types for semantic predicates allows for inferencing semantic properties from the 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.
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 sortal desambiguation in the transfer module. Moreover, sorts can be used to express lexical underspecification, e.g. for the representation of polysemy that holds across languages.[4]
In UMRS an SR is defined as a set-valued conjunction of predicates represented as a flat list of relation types. 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

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

[4]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 *institution;building;collective*) that leaves the specification of the institutional, spatial or staff reading underspecified. If necessary for specific transfer tasks, the disjunctive sort can be resolved.

relations by pointing to the highest handel of the embedded relation cluster. 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 modificandi can be kept underspecified by leaving the respective coindexations uninstantiated and storing the range of reasonable HD/INST values in the operator relation (for possible elements of the scope domain) or in the relation of the modificandum (for possible attachment sites).[5] Thus, an ambiguous representation bears a number of handel chains that can be chained together in a subsequent resolution process if required for a specific translation task, cf. [Lebeth and Schilder, 1996].

4 The Transfer System MinT

In the architecture of the MinT system, the declarative rule base is strictly separated from its processing environment. The basic rule schema of MinT takes pattern from the MRS-based transfer outlined in [Copestake et al., 1995]; we will refer to it as the *classical transfer correspondence* (TC). A classical TC is defined as a mapping between sets of source UMRS relations and sets of target UMRS relations.[6]

(1) $\langle set\text{-}of\text{-}SL\text{-}relations \rangle \Leftrightarrow \langle set\text{-}of\text{-}TL\text{-}relations \rangle$

The advantage of operating on a set of UMRS predicates lies in the use of type-based feature structures. There are at least three major points in favor of the use of types and features in a transfer system:
First, the reference to higher types in the SL part of TCs allows to generalize the mapping of predicates that fall into the same semantic class w.r.t. a specific property. This strategy minimizes both the amount of transfer rules and the expense of transfer operations.
Second, MRS-based transfer allows for a combination of the transfer and interlingua approach, cf. section 2. Coindexation of FS can be seen as the interlingual part in MRS-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 (speaking figuratively, they are moved up in the Vauquois-triangle) and thus allows for a broader range of target lexicalizations.

Let us introduce the basic transfer mechanism by giving a simple example. The various TL correspondences of the German verb *verlegen* in (2) - (4) can be desambiguated by sortal constraints on the instance of its ARG3. Thus, the correspondence between *verlegen* and *postpone*, cf. (2), is valid if this instance is a *situation*, cf. (5).[7] For the readings in (3) and (4) the ARG3 have to be sorted as *institution* or *movable_object*, respectively.

(2) einen Termin *verlegen* - to *postpone* an appointment
(3) eine Firma *verlegen* - to *transfer* a company
(4) einen Notizzettel *verlegen* - to *misplace* a note

[5] In UMRS, an attribute PAIRS is used as storage.
[6] The MinT processor takes a list of FS of type *relation* as input, reduces the list step by step by transferring one or more of them with recourse to the rule data base, and yields a list of TL relations as output. For more technical details, see section 6.
[7] For better readability tags are marked with a prefix, i.e. *i* corresponds to instance, *h* to handel and *d* to designator.

(5) $\left\langle \begin{bmatrix} verlegen & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG1} & \boxed{i2} \\ \text{ARG3} & \boxed{i3} \quad situation \end{bmatrix} \right\rangle \Leftrightarrow \left\langle \begin{bmatrix} postpone & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG1} & \boxed{i2} \\ \text{ARG3} & \boxed{i3} \end{bmatrix} \right\rangle$

As elaborated in [Abb and Buschbeck-Wolf, 1995], classical TCs suffice to treat a variety of phenomena, such as collocations, light verb constructions, phrasal expressions, mismatches, incorporation, head and category switching. However, classical TCs are not expressive enough to cope with all translation phenomena. Therefore, we made two extensions in MinT: one that concerns the rule schema and the other one that concerns the overall architecture.

For a number of transfer tasks, it is necessary to get information from the extralinguistic context (e.g. dialog acts) or directly from the linguistic context, i.e. the set of input relations that are not part of the local translation task. Thus, we introduce so-called *conditioned TCs* with an extra list for transfer conditions.[8] Consider the following examples:

(6) Das sind die *übrigen* Termine. - These are the *remaining* dates.
(7) Diese Termine sind *übrig*. - These dates are *left*.

In (6) and (7) the translation of *übrig* can be determined by verifying whether it functions as the predicative of the copula or as a noun modifier, cf. (8) and (9) respectively.[9]

(8) $\left\langle \begin{bmatrix} uebrig & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \end{bmatrix} \right\rangle, \left\langle \begin{bmatrix} noun & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \end{bmatrix} \right\rangle \Leftrightarrow \left\langle \begin{bmatrix} remaining & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \end{bmatrix} \right\rangle$

(9) $\left\langle \begin{bmatrix} uebrig & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \end{bmatrix} \right\rangle, \left\langle \begin{bmatrix} copula & \\ \text{HD} & \boxed{h2} \\ \text{INST} & \boxed{i2} \\ \text{HD\_ARG} & \boxed{h1} \end{bmatrix} \right\rangle \Leftrightarrow \left\langle \begin{bmatrix} left & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \end{bmatrix} \right\rangle$

As a further extension, we propose to split the transfer module in a monolingual and a bilingual component. There are at least two motivations for this architecture:

On the one hand, it might be necessary to adjust the SL FS in such a way that divergences in the semantic representation for a language pair can be bridged. For example, languages may diverge w.r.t. whether they allow a verbal or predicative construction:

(10a) Er äusserte sich kritisch/verächtlich.
(10b) *He expressed/uttered himself critically/disparaging.
(10c) He was critical/disparaging.

This is a case of category switching, where it is necessary to reorganize the source SR before it is passed to the bilingual component, cf. (11).

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

[8] For the sake of simplicity, we ignore that a bidirectional rule requires a TL condition part, too.

[9] In UMRS, both intersective adjectives and adverbs share the same semantic representation, i.e. the syntactic categorization is abstracted away from. This analysis is motivated twofold: First, it is undesirable to generate out of a category-specific SR. Second, this underspecified representation supports an efficient transfer since, in the majority of cases, their translation does not alter w.r.t. the adjective/adverb distinction.

The monolingual TC says that if *aeussern* is modified by an adverb of the type *opinion_adv* then this relation cluster is substituted by the copula relation with the adverb embedded as predicative. In UMRS, subject and predicative of the copula share the same instance (see also, e.g., [Pollard and Sag, 1994]). Thus the adverb's instance must be coindexed with the ARG1 of *aeussern* or the subject of the copula, respectively.[10]
On the other hand, it is often required to have predicates desambiguated before other transfer operations could start. Therefore, we assume the monolingual component to refine particular ambiguous predicates before the actual transfer. We will address this problem in detail in section 5.2.

5 Examples

To demonstrate the use of abstract predicates in transfer let us regard utterances that express attitudes, which occur very frequently in the domain of appointment scheduling. Beside the transfer of bilingual synonym classes we regard phenomena of semantic reconstruction, such as incorporation and head switching, and show how prepositions are desambiguated in the monolingual module.

5.1 The use of abstract predicates in transfer

With the traditional strategy to relate SL-specific predicates directly to TL-specific predicates, generation looses 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 synonymous predicates. The abstraction process is gained via type inference. 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.

(12a) Der Dienstag *passt* bei mir /*geht* bei mir /*klappt* bei mir.
(12b) Tuesday *suits* me /*works* for me.

To verbalize that something suits somebody, German and English offer a variety of verbs, cf. (12), which leads us to introduce the type *abstr_suit_sit* in the German and the English relation hierarchies (13).[11] (14) presents the TC for the abstract predicate *abstr_suit_sit*.

(13a) abstr_suit_sit = passen | klappen | gehen.
(13b) abstr_suit_sit = suit | work.

(14)
$$\left\langle \begin{bmatrix} \textit{abstr\_suit\_sit} \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG3} & \boxed{i2} \end{bmatrix} \right\rangle \Leftrightarrow \left\langle \begin{bmatrix} \textit{abstr\_suit\_sit} \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG3} & \boxed{i2} \end{bmatrix} \right\rangle$$

(15) exemplifies attitude-expressing adverbs that correspond to each other as a whole class. Figure 1 shows synonym classes that can be distinguished in this domain. Table 1 presents the corresponding

[10] Note that one would need a number of conditioned TCs to cope with the data, because this rule type allows the verification but not the manipulation of relations in the condition part.

[11] The type hierarchy is specified in CUF, cf. [Dörre et al., 1994]. The symbol "=" specifies the relation between a type and its subtypes. Disjointness and exhaustivity are expressed by the symbol "|".

SL and TL lexicalizations.

(15a) Montag/das ist *gut/angenehm/schön/okay* (bei mir/für mich).
(15b) Monday/this is *good/convenient/fine/okay/all right* (for me).

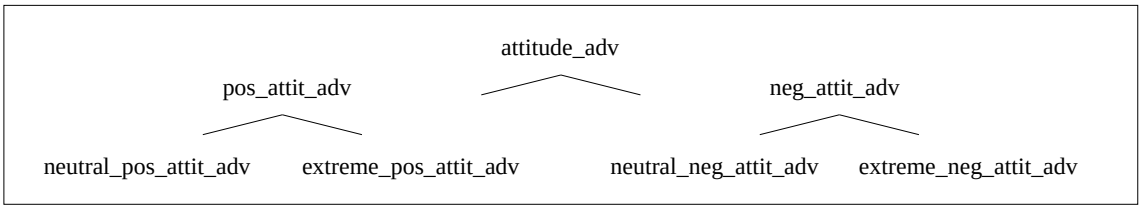


Figure 1: Partition of synonymous classes of attitude-expressing adverbs

attitude_adv	German lexicalization	English lexicalization
neutral_pos	gut, angenehm, schön, okay	good, convenient, fine, okay, allright
extreme_pos	wunderbar, hervorragend, klasse, super	excellent, wonderful, great, fantastic
neutral_neg	schlecht, ungeschickt, ungünstig	bad, inconvenient
extreme_neg	übel, unmöglich, ausgeschlossen	impossible, out

Table 1: Domain specific synonyms of attitude-expressing adverbs

In contrast to (12), the adverbs in (15) are synonymous only in particular contexts, i.e. if they describe the speaker's attitude towards a proposed time or event. A TC with an abstract type for these adverbs has to consider the context. The rule in (16) requires that the abstract adverbial predicate is the predicative of the copula. This is expressed by the coindexation of the copula's HD_ARG with the HD of the adverb. Futhermore, the instance of the adverb which is shared by the subject of the copula is restricted to the sort *temporal* which subsumes times and events. If the theme was expressed anaphorically, the anaphora resolution instantiates the sort of the antecedent.

(16)
$$\left\langle \begin{bmatrix} neutral\_pos\_attit\_adv \\ \text{HD} \quad \boxed{h1} \\ \text{INST} \quad \boxed{i1}\ temporal \end{bmatrix} \right\rangle, \left\langle \begin{bmatrix} copula \\ \text{HD} \quad \boxed{h2} \\ \text{INST} \quad \boxed{i2} \\ \text{HD\_ARG} \quad \boxed{h1} \end{bmatrix} \right\rangle \Leftrightarrow \left\langle \begin{bmatrix} neutral\_pos\_attit\_adv \\ \text{HD} \quad \boxed{h1} \\ \text{INST} \quad \boxed{i1} \end{bmatrix} \right\rangle$$

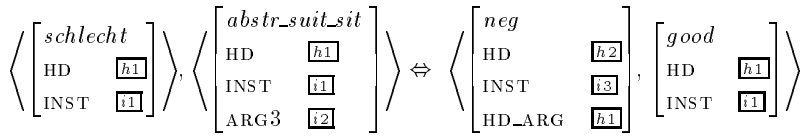
Abstract types are also used to describe other transfer mappings in an efficient way. We demonstrate this by a case of *semantic restructuring*, cf. (17), a case of *incorporation*, cf. (19), and a case of *head switching*, cf. (22).

(17a) Das passt/geht/klappt (bei mir) *schlecht*.
(17b) That does *not* suit me /work (for me) *well*.

(17) exemplifies a problem with the translation of the predicate *schlecht* in case where it modifies verbs expressing a positive attitude. In English negative attitude adverbs cannot be combined with this kind of verbs ([Condorvardi and Sanfilippo, 1987]). Thus, in the translation *schlecht* has to be mapped on its TL antonym *good* and the verb has to be put under the scope of negation, cf. (18).[12]

[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 (cf. section 3) of the corresponding scope domain must be updated by adding to it the negation's HANDEL/INST values.

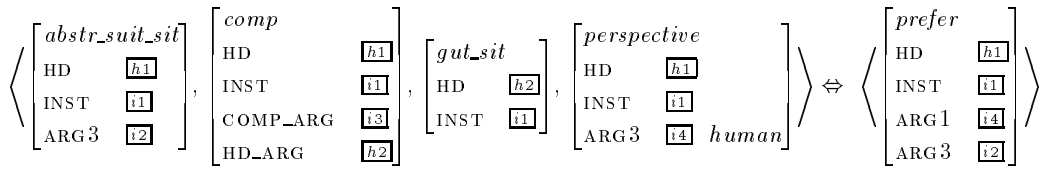
For this mapping, the modificandum is represented as the abstract type *abstr_suit_sit* in the condition part. This allows to restrict the mapping to the relevant context and to anchor the scope of the negation to the right place, namely the situation handel.[13]

(18)


Let as consider a case of incorporation as a further example, cf. (19). The preferred way to express in English the fact that something suits someone is to say that he or she prefers it.

(19a) Dienstag würde bei mir besser *passen/klappen/gehen.*
(19b) I would *prefer* Tuesday.

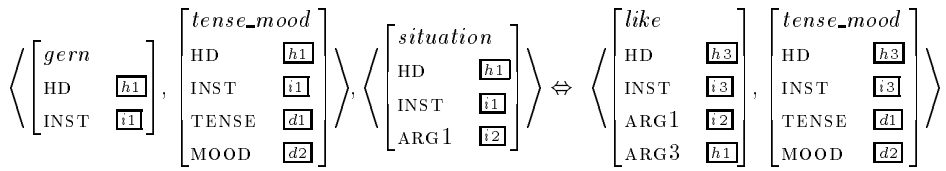
The TC in (20) shows the mapping of a complex German predicate list to the English verb *prefer*. In UMRS comparatives are decomposed into a comparative relation *comp* and the adjective's positive form, in our case *gut*. In (20) the comparative *besser* as well as the *bei*-PP modify the attitude verb of type *abstr_suit_sit*. We assume that the PP has already been assigned the *perspective* interpretation in the monolingual component, cf. 5.2. This is necessary because *bei* with an internal argument which denotes a human being may also have a spatial interpretation, for which the translation in (19b) would not be feasible. Note, that the use of the type *abstr_suit_sit* in (20) avoids the multiplication of the rule for each attitude verb.

(20)


Finally, let us regard the case of head switching in (21).

(21) Ich würde Sie gerne morgen treffen - I would like to meet you tomorrow.

Here, the meaning of the German modifier *gerne* corresponds to the English modality state of *liking*. *Like* is a control verb which embeds the situation modified by *gerne* in the SL as its ARG3, cf. (22). Anchoring the *situation* type in the condition part, the concrete situation is abstracted away from and translated separately. Its ARG1 is coindexed with the highest argument of *like* 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 *like*.

(22)


[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. They regard the choice between *bad* - the standard translation of *schlecht* - and *not good* as a generation problem which should be solved by TL cooccurence restrictions.

5.2 Refinement in the monolingual component of MinT

To motivate the necessity of an additional refinement step in the monolingual component, let us regard the treatment of prepositions, cf. section 4. 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 desambiguation in the bilingual module, cf. (20) in section 5.1.
We show the refinement procedure with the example of the German preposition *bei*. In most cases, sortal constraints on its internal argument are sufficient to identifiy the intended meaning.[14] 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 and the unspecified spatial interpretation of the *bei*-PP, cf. (23) and (24).

(23) Geht/klappt es *bei Ihnen*?
(23a) Does it suit *you*?
(23b) Is it possible *at your place*?

(24) Das ist schlecht/ungünstig/unmöglich *bei mir*.
(24a) This is bad/inconvenient/impossible *for me*.
(24b) This is bad/inconvenient/impossible *at my place*.

This kind of ambiguity can be further confined. If the attitude refers directly or anaphorically to a time expression the spatial interpretation of the *bei*-PP is impossible,[15] because times - in contrast to situations and things - cannot be located in space. Therefore, we provide the refinement rule in (25), where the sortal constraint *time* on the ARG3 of an attitude verb and on the INST of an attitude adverb forces the perspective reading.[16]

(25)
$$\left\langle \begin{bmatrix} bei & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG3} & \boxed{i2}\ human \end{bmatrix} \right\rangle, \left\langle \begin{bmatrix} abstr\_suit\_sit & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG3} & \boxed{i3}\ time \end{bmatrix} \right\rangle ; \left(\begin{bmatrix} copula & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{HD\_ARG} & \boxed{h2} \end{bmatrix}, \begin{bmatrix} attitude\_adv & \\ \text{HD} & \boxed{h2} \\ \text{INST} & \boxed{i3}\ time \end{bmatrix} \right) \Rightarrow \left\langle \begin{bmatrix} perspective & \\ \text{HD} & \boxed{h1} \\ \text{INST} & \boxed{i1} \\ \text{ARG3} & \boxed{i2} \end{bmatrix} \right\rangle$$

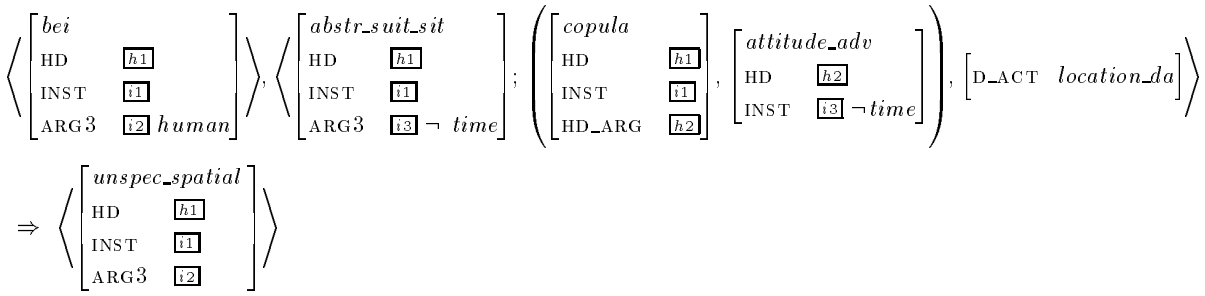
Let us go back to the examples in (23) and (24). Here, the theme of the attitude verb is realized by event type pronouns. The antecedent being a situation, the ambiguity of the *bei*-PP cannot be resolved even by anaphora resolution. To figure out which reading is intended, we use information from the dialog module, which provides the dialog acts of all utterances, cf. [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 derive heuristically that the spatial interpretation of *bei* is the appropriate one. (26) shows the corresponding refinement rule which includes the verification of the dialog act *location_da*.[17] A further rule with the negation of the dialog act type *location_da* maps *bei* to *perspective*.

[14] For example, an unspecified spatial reading of *bei* can be identified if the internal argument refers to a human being (cf. *bei* Peter - *at* Peter's place), a temporal-spatial one, if it is a situation (cf. *bei* der Vorlesung - *at* the lecture), or a concrete spatial interpretation, if it is a thing or location (cf. *bei* Berlin - *near* Berlin).

[15] Cf. (i) Geht Montag *bei Ihnen*? - *Is Monday possible *at your place*
(ii) Montag ist schlecht/ungünstig/ unmöglich *bei mir*. - * Monday is bad/inconvenient/impossible *for me*.

[16] Disjunctive specifications of FS are not part of the CUF formalism. They are treated by the compiler.

[17] The dialog act type *location_da* describes all dialog acts the topic of which is a location. It abstracts away from the concrete speech act, since for this particular purpose it is not relevant whether a location is requested, suggested, accepted etc.

(26)


6 Implementational Issues

MinT is implemented and tested for a representative part of the Verbmobil dialogs. The declarative data base, i.e. the TCs and the type hierarchies of relations and sorts are specified in CUF. 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 type *relation* as input and processes it in two steps: In the monolingual stage, the SL list is transformed into a (possibly) refined and adjusted SL list. The transformed SL list forms the input of 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 one-to-n TC even if the total complexity of the one-to-n TC is higher.

7 Summary and Further Research

In this paper we presented a semantic transfer approach that relies on the use of unification as basic transfer operation. It allows to implement 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 of the amount of transfer rules and the expense of transfer operations.

We have argued for a two-level transfer that integrates a monolingual preprocessor. The monolingual component is used to adjust divergences in LF and to refine ambiguous predicates if necessary for the bilingual component.

Future research concerns the question on 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, cf. section 5.1. We also assume abstractions on the lexico-conceptual level, such as a common representation of graduals and their graduated properties, e.g. *sehr gut* - *very good*, and their lexicalized synonyms, e.g. *wunderbar* - *wonderful*.

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