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What you Always Wanted to Know About Semantic Transfer

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Gehört zum Antragsabschnitt: 12.4 Kontextuelle Constraints
12.6 Äquivalentwahl

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Abstract

The transfer in Verb*mobil* is primarily semantic-based. To further move up the level of abstractness, it integrates a variety of interlingual elements that allow the generation of alternative translations.

In this report, we present the treatment and implementation of translational phenomena on both levels. Concerning the conceptual mapping level, we focus on problems of lexical and structural abstraction by generalization and decomposition. With respect to the semantic mapping level, we give an insight into the treatment of a wide range of structural divergences.

Another topic of this report is the resolution of translational ambiguities which is relevant on both mapping levels. A catalog of examples will provide an overview over the various types of contextual constraints used for disambiguation.

Contents

1 Introduction

In this report, we present some of the linguistic details of the German-English transfer component of the face-to-face MT system Verb*mobil*.[1]

Verb*mobil* is designed to produce English output for spoken German and Japanese input in the domain of appointment scheduling dialogs. For details on the overall architecture of the Verb*mobil* system, we refer to ([Wahlster, 1993]).

The transfer component of Verb*mobil* in its present implementation ([Dorna and Emele, 1996b]), is based on a *lexicalist semantic approach* which takes its roots in MRS-based transfer ([Copestake et al., 1995] and [Abb and Buschbeck-Wolf, 1995]) and the Shake-and-Bake approach to MT ([Whitelock, 1992]). The relation between source language (SL) and target language (TL) structures is established on a relatively abstract level of representation. Compared with syntactic transfer approaches ([Slocum et al., 1987], [Kaplan et al., 1989] and [Eberle and Lehmann, 1993]) , the translation step on a semantic level is much simpler since the gap between the SL and the TL repesentations is not as deep.

One of the central requirements to an efficient MT system is the reduction of analysis and transfer efforts to the necessary minimum ([Kay et al., 1994]). Concerning the analysis, this can be reached by leaving ambiguities that hold across the involved languages underspecified (see section 2.2). Concerning transfer, among others, the use of techniques of generalization, and decomposition can be employed to further minimize both the amount of transfer rules and the expense of transfer operations (see section 4).

Since structural divergences between languages, such as head and category switching, incorporation and reduction pose problems to almost every MT system, we present how they are treated in the Verb*mobil* transfer component. Another point of general interest is the resolution of translational ambiguities. We demonstrate this topic in more detail by presenting the various types of contextual constraints used for disambiguation.

This report is organized as follows: section 2 describes the semantic representation which forms the input to the transfer component. In section 3, we sketch the transfer approach and describe the main knowlegde bases of this component. In section 4, we focus on methods of concept-based transfer that are used to move up the level of abstractness. Section 4 illustrates the treatment of well-known structural divergences with a series of examples. Section 6 is devoted to the disambiguation of translational ambiguities. Finally, section 7 summarizes the most important features of our transfer approach.

[1]We would like to express our gratitude to Bernd Abb, Marc Beers, Michael Dorna, Martin Emele and Rita Nübel for most valuable comments on the topics of this report.

2 Semantic Representations

Let us first describe the semantic representation that forms the input to the transfer module.

There are two semantic construction components that provide the transfer with input, one uses LUD (Language for Underspecified Discourse) ([Bos et al., 1996b]), and the other one UMRS (Underspecified Minimal Recursion Semantics) ([Egg and Lebeth, 1995]) as semantic formalism.

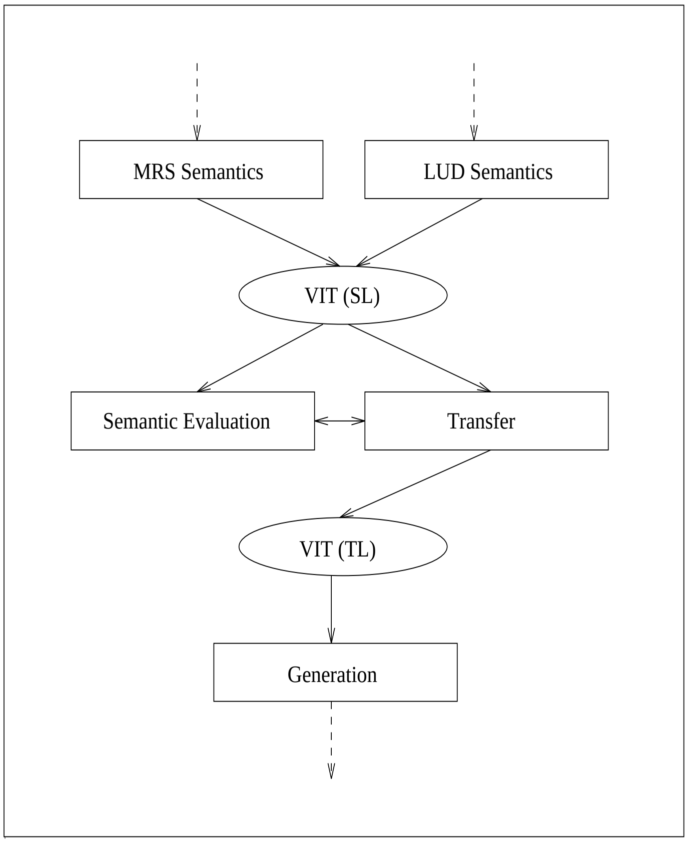

Figure 1: Data structures between the linguistic components

The structures produced by the semantic construction components are converted into a common VIT (Verb*mobil* Interface Term) representation ([Dorna, 1996]). A VIT is an abstract data structure that is used as interface representation between semantic construction and semantic evaluation, semantic construction and transfer, as well as between transfer and generation, see Figure 1.

2.1 Verb*mobil* Interface Terms

A VIT represents a ten place prolog term of the following form ([Bos et al., 1996a]):

(1) `vit(UtteranceID,Semantics,MainCondition,Sorts,Discourse,Syntax,`
`TenseAndAspect,Prosody,Scope,Groupings)`

The **Semantics** slot represents a list of connected predicates. Each semantic predicate has a label (`Label`) that serves as address for the representation of all kinds of semantic embedding. The labelling allows a non-recursive set-oriented semantic representation which is convenient for the specification of transfer operations. Besides their label, referential predicates introduce an instance (`Inst`) .

The **UtteranceID** is a tag for the utterance which is represented in the VIT.

The **MainCondition** introduces the hightest label of the utterance. It is the entry point for traversing the VIT.

In the **Sorts** slot the sortal information (`sa_sort(Inst,Sort)`) of referential predicates is encoded. It is used for disambiguation (see section 6.1).

The **Discourse** slot contains information about the reference and the type of anaphors (`prontype(Inst,PronRef,Prontype)`), the directionality of prepositions (`dir(Inst,YesNo)`), and the current dialog act (`dialog_act(Inst,DialogAct)`), which is provided by the semantic evaluation component ([Jekat et al., 1995]).

The **Syntax** slot stores the number (`num(Inst,Number)`), case (`cas(Inst,Case)`), gender (`gend(Inst,Gender)`) and person (`pers(Inst,Person)`) values of the particular semantic predicates.

A further **TenseAndAspect** slot provides the tense (`ta_tense(Inst,Tense)`) and mood information (`ta_mood(Inst,Mood)`) of verbal predicates, as well as the result of the aktionsart calculation (`aktionsart(Inst,Aktionsart)`).

The **Prosody** slot contains information about the prosodic accent (`pros_accent(Label)`), the prosodic mood (`pros_mood(Label)`) and b3 boundaries (`pros_boundary(Label,ProsMood)`).

The **Scope** and **Grouping** slots are used for the representation of underspecified scope, see below.

Argument structure and modification is expressed by the coindexation of instances in a Neo-Davidsonian way of representation. Regard the VIT fragment for the sentence (2) in (3):

(2) Ich würde das Treffen gerne um 10 Uhr anfangen.
('I would like to arrange the meeting at 10 o'clock.')

(3)
```
anfangen(l1,i1),
arg1(l1,i1,i2),
arg3(l1,i1,i3),
gerne(l2,i1),
um(l3,i1,i4),
pron(l4,i2),
treffen(l5,i3),
clocktime(l6,i4,10),
sem_group(l7,[l1,l2,l3])
```

The verbal predicate `anfangen` with the label `l1` and the index `i1` shares these variables with its arguments `arg1(l1,i1,i2)` and `arg3(l1,i1,i3)`; `i2` and `i3` are the instances of the argument fillers that are introduced by the predicates `pron(l4,i2)` and `treffen(l5,i3)`.

The modifiers `gerne(l2,i1)` and `um(l3,i1,i4)` share only the index variable with `anfangen(l1,i1)`. By the method of grouping (`sem_group(l7,[l1,l2,l3])`), which provides group labels as address for possible scope domains, the set of the labels `l1`, `l2` and `l3` is assigned the group label `l7`.[2] Thus, this set of predicates might enter a scope relation as a single unit.

Semantic Subordination such as scope, coordination and propositional embedding are represented in an underspecified way ([Bos, 1996]). Scope bearing predicates provide, besides a label and an instance, a hole variable for their underspecified scope which is constrained by `leq` ('less or equal') statements. `leq`-constraints describe direct (equal) or indirect (less) subordination relations between label variables (holes) and label constants (group labels).

Another way of expressing semantic embedding is the direct coindexation of labels. This is used for the representation of the scope of graduals over modifiers and for the embedding of the copula's predicative.[3]

Let us regard the representation of scopal and propositional embedding for the example (4) with the VIT in (5).

(4) Vielleicht sollten wir das am Montag ausmachen.
('Maybe we should arrange that on Monday.')

[2]These are the labels of the predicates that belong to the referent with the index `i1` (intersective modification).

[3]The copula (`support(Label,Inst,Label1)`) is a three-place predicate with a label, an instance and a label argument that is shared by the label of the predicative. The predicative's instance is coindexed with the instance of the copula's subject.

(5)

```
vit( segment_description('vielleicht sollten wir das am montag ausmachen'),
[ausmachen(l5,i2),                     % Semantics
 decl(l10,h2),
 vielleicht(l9,i6,h3),
 sollen(l8,i1,h1),
 an(l7,i2,i3),
 dofw(l6,i3,mon),
 arg1(l5,i2,i5),
 arg3(l5,i2,i4),
 pron(l15,i5),
 pron(l14,i4),
 def(l13,i3,l2)],
l10,                                   % Main Label
[s_sort(i1,mental_sit),                % Sorts
 s_sort(i2,communicat_sit),
 s_sort(i3,time),
 s_sort(i4,space_time),
 s_sort(i5,human)],
[dir(l7,no),                           % Discourse
 prontype(i5,sp_he,std),
 prontype(i4,third,demon)],
[num(i5,pl),                           % Syntax
 pers(i5,1),
 gend(i4,neut),
 num(i4,sg),
 pers(i4,3),
 cas(i4,acc),
 cas(i5,nom)],
[ta_tense(i2,infin),                   % Tense and Aspect
 ta_mood(i1,ind),
 ta_tense(i1,praet)],
[leq(l4,h2),                           % Scope
 leq(l3,h3),
 leq(l3,h2),
 leq(l3,h1),
 leq(l1,h2),
[pros_mood(l10,decl)],                 % Prosody
[sem_group(l3,[l7,l5]),                % Groupings
 sem_group(l4,[l9]),
 sem_group(l2,[l6]),
 sem_group(l1,[l8])])
```

The highest label `l10` bears the sentence mood operator `decl(l10,h2)` (declarative). Its scope is restricted by the subordination constraints `leq(l1,h2)` and `leq(l3,h2)`, i.e. it is above the modal verb (group label `l1`) and its embedded proposition (group label `l3`).

The modal verb `sollen(l8,i1,h1)` introduces as scope domain the hole `h1` which is constrained by `leq(l3,h1)`, i.e. it embeds the `ausmachen(l5,i2)` proposition. This subordination restricts the scope alternatives of the sentence mood operator respectively.

The scope domain `h3` of the modal operator `vielleicht(l9,i6,h3)` is bound by the constraint `leq(l3,h3)`. It has direct or indirect scope over the `ausmachen(l5,i2)` proposition. This constraint leaves the subordination relation between `vielleicht(l9,i6,h3)` and the modal verb `sollen(l8,i1,h1)` underspecified. Thus, both possible scope interpretations of the modal operator are captured by this kind of representation.

2.2 Ambiguity Preservation

In order to avoid expensive resolution procedures, it is most desirable to preserve ambiguities that hold within a language pair ([Alshawi et al., 1991] and [Kay et al., 1994]). Considering the language pair German-English, these are among others:

- Scope ambiguities
- Modifier attachment ambiguities
- Polysemy
- Interpretation of possessive relations

Ambiguity preservation is primarily a representational problem. An underspecified semantic representation should comprise all possible interpretations, such that in cases a resolution is required, one of the readings can be instantiated. The most important advantage of ambiguity preservation techniques is the reduction of the analysis effort to the minimum necessary.

As we have shown in section 2.1, the semantic representation we use allows the **underspecification of scope ambiguities** ([Bos, 1996]). Since they are in almost all cases not relevant for translation (see example (5)), the transfer component transmits underspecified scope representations to the generator.

Modifier attachment ambiguities which are inherent to prepositional modifiers and adverbial modifiers can often be left unresolved. In most cases, the modified predicate does not influcence the translation of the modifier and vice versa.[4]

In (7), for example, the temporal adverb *morgens* ('in the morning') has two possible attachment sites. It modifies either *Termin* ('appointment') or *ausmachen* ('arrange').

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

Since in the VIT representation used in transfer, modifiers are attached uniquely, we will demonstrate the representation of this kind of underspecification with the UMRS analysis.

As shown in [Egg and Lebeth, 1995], in UMRS, the connection 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[5] as a list of disjunctions. This is shown in (7), where the attribute PAIRS provides the HD/INST values of *Termin* and *ausmachen*.[6]

(7)

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

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. **systematical polysemy** ([Copestake and Briscoe, 1995]), which shows up in the domain of nomimal predicates. In (8), for example, *Universität* and *university* are ambiguous in a parallel fashion. They may denote an institution (8a), a location housing the institution (8b), or a group of people associated with it (8c).

[4] A counterexample is given section 4.1.3.

[5] The attribute handel HD corresponds to the label in the VIT representation.

[6] In UMRS, ambiguous scope is represented by the attribute OP_DOMAIN that is introduced by scope operators. It stores the list of all HD values that occur as possible scope domains of the operator.

(8a) an der *Universität* arbeiten - work at the *university*
(8b) die Haltestelle bei der *Universität* - the stop next to the *university*
(8c) die *Universität* streikt - the *university* is on strike

In order to preserve this, in fact sortal ambiguity, we make use of underspecified sortal specifications on the predicate's instances. This is expressed by disjunctive sortal types that are declared in the sort hierarchy (see Figure 4 in the Appendix). For example, the instance of *university* is assigned the sort `inst_loc_coll` (defined as the disjunction of the sorts `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.

Finally, let us regard the **interpretation of possessive relations** with the examples in (9).

(9) meine Firma - my company
Schmidts Firma - Smith's company

In both languages, possessive pronouns and prenominal genitives indicate a similar vague relation between the two constituents - the possessor and the possessed. The relation between the person and the company in (9) might be, for instance, that of an ownership, an employment or an advisership, etc. ([Haider, 1988]). The vagueness of this kind of relation is expressed by the three-place predicate `L:poss(Inst1,Inst2)`, where `I1` is the instance of the possessed and `Inst2` the one of the possessor. The `poss` relation could be regarded as an maximally underspecified relation that means nothing more than "to be associated with" and is in most cases sufficient for translation. If required this relation can be refined ([Gerstl, 1994]).

A similar approach is appropriate for the representation of NN compounds. If we assume the unspecified relation `L:unspec(Inst1,Inst2)` between their constituents as a top-level type of a hierarchy of more specific relations, such as those denoted by prepositions, a refinement of this relation can be instantiated if necessary for the translation of a compound.

3 Transfer

3.1 The Overall Architecture

In Verb*mobil*, the transfer component gets its input from the semantic construction and delivers its output to the generator. It also has an interface to the semantic evaluation component which provides information about the dialog context and the speech acts by integrating domain-specific world knowledge (see section 6.8).

With regard to Figure 1, the transfer component relates underspecified SL semantic representations (SL VITs) to underspecified TL semantic representations (TL VITs) by applying transfer statements (see section 3.2.1).

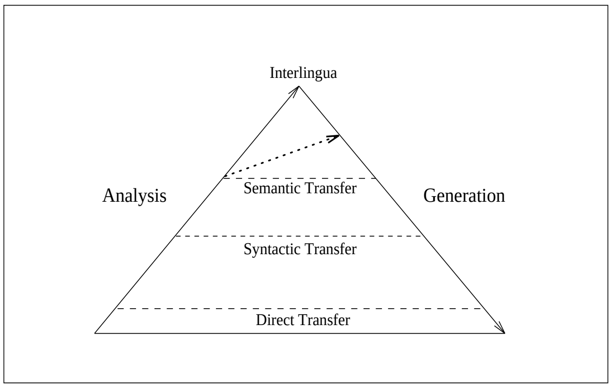

Figure 2: Vauquois' Triangle

W.r.t. the Vauquois' triangle ([Vauquois, 1975]) in Figure 2,[7] semantic transfer operates on a relatively abstract level of representation. Here, morphosyntactic realizations are abstracted away from and a variety of language-independent categories, such as referentiality, tense, mood and time, etc. is introduced. Moreover, the used semantic formalism allows to leave particular ambiguities that hold across languages unresolved (see section 2.2). These are only some of the advantages that motivate our choice for a semantic transfer approach which seems to be the most reasonable tradeoff between the traditional transfer and interlingua (IL) approach. For a more detailed discussion on this topic, we refer to [Copestake, 1995].

In order to raise the mapping level w.r.t. the Vauquois Triangle as high as possible, without falling back into the well-known problems of the interlin-

[7]The Vauquois' triangle illustrates the principle: The deeper the analysis the simpler the actual translation step.

gua approach,[8] we increase the language-independency of the representation by employing techniques of *generalization* (see section 4.1) and *decomposition* (see section 4.2). This is indicated by the dotted line in Figure 2.

By the use of bilingual predicates that abstract away from the concrete lexicalization or grammaticalization and by the decomposition of complex predicates into language-independent semantic primitives, we approach partial language-neutral representations that allow the generator to produce alternative translations. Generalization and decomposition lead to a reduction of the redundancy of transfer statements to the necessary minimum.

3.2 The Knowledge Bases of the Transfer Component

The primary knowledge bases of the transfer component are the data base of transfer equivalences, the set of monolingual refinement and restructuring rules and the bilingual type declarations. All knowledge bases are implemented in Prolog. We will not say much about the implementational details here. For this, we refer to [Dorna and Emele, 1996b] and [Dorna and Emele, 1996a].

3.2.1 Transfer Equivalences

(10) `[Set_of_SL_Sem],[Set_of_SL_Cond] TauOp [Set_of_TL_Sem],[Set_of_TL_Cond].`

The general form of a transfer statement is shown in (10). It establishes the equivalence between sets of SL semantic predicates (`Set_of_SL_Sem`) and sets of TL semantic predicates (`Set_of_TL_Sem`). The operator `TauOp` indicates in which direction the rule is applied, i.e. $\leftrightarrow$, $\rightarrow$ or $\leftarrow$.[9]

The rules are optionally provided with a condition part (`Set_of_SL_Cond`) that serves to restrict the range of their application to the relevant context. The context itself is not manipulated. As a consequence, the translation units can be kept small and problems with the interaction of rules can be minimized.

With respect to the complexity of the SL predicate part, we distinguish *simple rules* from *complex rules*. Simple rules map just one predicate. Complex rules manipulate more than one predicate. They are used for all kinds of phrasal transfer.

[8] Although the IL approach is known to have various advantages, most notably language pair independence ([Hutchins and Somers, 1992]), 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.

[9] In the following, we regard only the direction $\rightarrow$, which allows to ignore the TL conditions.

Depending on the existence of a condition we differentiate between *context-sensitive and context-free rules*. The condition list (`Set_of_SL_Cond`) might contain sets of SL predicates to fix the semantic context, restrictions on the sort or a particular type of a predicate, scope, mood, number and aktionsart information as well as extralinguistic information, such as the current dialog act or the dialog history (for examples, see section 6).

The rule application is guided by two principles: complex rules are preferred to simple ones, and context-sensitive rules are applied before context-free ones, i.e. the most specific rule is chosen first.

In order to improve the readibility of the transfer rules in the following sections, let us briefly introduce some frequently used conditions. All predicates contained in the VIT can be included into the condition part to fix the applicability of a transfer mapping. For details, we refer to the VIT description in section 2.1 and to [Dorna, 1996]. Table 1 displays the syntax of some further contextual restrictions and sketches their interpretation.

Condition	Interpretation
`Label:Pred`	Existence of a particular VIT predicate
`not(Label:Pred)`	Non-existence of a particular VIT predicate
`unifiable(Inst,Sort,S)`	Unifyability of `Inst`'s sort with a required `Sort` which is a type of the CUF sort hierarchy
`Label:rel(VitClass,Inst)`	Membership of a predicate addressed by its `Label` and `Inst` to a particular semantic class (`VitClass`)
`Label =< Label1`	`Label` is accessable from `Label1` by a label chain
`Label \== Label1`	`Label` and `Label1` are not identical
`main_label(Label)`	`Label` is the main label of the utterance
`get_group_label(Label,GLabel)`	`GLabel` is the group label of the predicate addressed by `Label`
`sent_mood(SentMood)`	Mood of the current utterance
`temp_persp(Inst,Now/NotNow)`	Temporal perspective point of an utterance

Table 1: Selected Conditions Used to Restrict Transfer Mappings

Let us briefly describe the manipulation of groupings. Groupings provide pointers (group labels) to a list of labels that belong to predicates which enter an intersective modification structure (see section 2.1). For particular kinds of semantic reconstruction, we need to restructure the groupings too. This is achieved by the operations in (11) and (12), which are part of the rule's LHS.

(11a) `del_group_elem(Label,GLabel,RestLabels)`
(11b) `del_group_elems(Labels,GLabel,RestLabels)`

When deleting predicates that form part of an intersective modification structure or converting them into predicates with other semantic properties, their labels have to be removed from the corresponding groups. The operations in (11) take one label `Label` (11a) or a list of labels `Labels` (11b) out of the group addressed by the group label `GLabel` and store `RestLabels` - the rest of the labels contained in that group. On the TL side, the grouping is restored by the predicate `sem_group(GLabel,RestLabels)` which assigns the list of `RestLabels` the group label `GLabel`. By the use of list concatenation (expressed by "/"), labels can be added to that group.

(12) `add_to_group(NewLabel,Label)`

For inserting a new modifier in the TL, converting an argument into an intersective modifier, etc., the transfer compiler provides the operation in (12). It adds the label of the predicate in question `NewLabel` to the group that contains `Label`.

3.2.2 Monolingual Restructuring and Refinement Rules

For transfer-relevant restructuring and refinement of the SL representation we use a small set of monolingual rules.[10] They serve to adjust the SL representation in such a way that systematic divergences in the semantic structure of a language pair can be bridged. Furthermore, monolingual rules initiate further (de)composition, e.g. the introduction of abstractions over differently structured synonymous predications or the decomposition of compounds. Finally, they are employed for refinement processes. Particular ambiguous predicates have to be refined before the actual transfer mapping, since it is often required to have predicates disambiguated before other transfer operations can start. We will address this problem in section 4.1.3.

Since all restructuring and refinement operations are motivated by the contrastive data, we assume this set of monolingual mapping rules to be part of the transfer module. This way, the modularity of the SL grammar can be maintained.

(13) `[Set_of_SL_Sem],[Set_of_SL_Cond] -> [Set_of_SL_Sem].`

Monolingual rules, see (13), are context-sensitive or context-free mappings within the SL, i.e. mappings of sets of SL predicates to sets of SL predicates. They are applied before the bilingual transfer rules.

[10] For motivation, see also [Abb et al., 1996].

3.2.3 Bilingual Predicate Types

Bilingual predicate types are, on the one hand, meaning abstractions or concepts that bundle lexicalizations in the SL and the TL that are synonymous w.r.t. the considered domain. They allow to transfer predicates as a whole class, and thus, move up the mapping level. On the other hand, they are used to group predicates w.r.t. a specific property they have in common, e.g. in order to formulate contextual restrictions compactly, see section 5.4.2.

(14) `type(L,BilingPred,[Preds]).`

Bilingual types are declared by the definition shown in (14), where `L` is the considered language, `BilingPred` is the name of the bilingual predicate and `Preds` is a list of (contextually) synonymous predicates of the language `L`. By using types in the definition of other types it is also possible to construct a hierarchy (see section 4.1.1). In (15), for example, predicates with the meaning of approximative graduation are grouped together.

(15) `type(de,approx_grad,[etwa,ungefaehr,so,zirka]).`

Used in a transfer rule, such as in (16) the bilingual type is replaced by the predicates belonging to it; i.e. the transfer rule is multiplied for each predicate.

(16) `[L:approx_grad(F)] <-> [L:approx_grad(F)].`

In the MinT approach ([Abb and Buschbeck-Wolf, 1995]) which relies on a typed constraint-based formalism, one single type hierarchy is used for semantic construction and transfer. Bilingual types are introduced into the lower parts of the SL and TL predicate hierarchies. Their subtypes specify the range of possible lexicalizations in the particular language. The application of rules that map bilingual types, such as the one in (16), is based on type subsumption.

On the one hand, the use of a single hierarchy has the advantage that transfer can employ the all semantic properties available by inheritence, e.g. the belonging to a particular semantic class. On the other hand, the hierarchy's partion does not always support the requirements of the contrastive situation. E.g. it might be desirable to cluster predicates together that belong to different semantic types or to put one predicate under diffferent bilingual types. In this way, a separate type declaration, as introduced above, is more flexible. It allows an independent clustering of predicates, i.e. the partition can be tailored w.r.t. the the belongings of contrastive situation.

4 Concept-based Transfer

4.1 Abstraction by Generalization

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 predicates that fit the same meaning. Hence, it is reasonable to introduce bilingual concepts in the SL and TL that bundle various predicates that are synonymous in the considered domain. Let us demonstrate the mapping via meaning abstractions by verbs and adverbs that express an attitude (section 4.1.1), by intensifiers (section 4.1.1) and by prepositions (section 4.1.3).

4.1.1 Attitude Expressions

To verbalize that something suits somebody, German and English offer different verbs, such as in (17).

(17a) Der Montag *passt* bei mir */geht* bei mir */klappt* bei mir.
(17b) Monday *suits* me */works* me.

This leads us to introduce the bilingual type `abstr_suit`. The type definition in (18) shows which German predicates are subsumed by this type (see section 3.2.3). While in the SL part only predicates of the same semantic class are abstracted away from, the generation has no such restriction. Thus, the predicate `abstr_suit` gets also lexicalized by positive attitude adverbs, i.e. (21a) becomes a possible translation of (17a), see below.

(18) `type(de,abstr_suit,[gehen_passen,passen_suit,klappen]).`

The rule in (19) shows the mapping of all German attitude verbs declared by the bilingual predicate `abstr_suit` in (18).

(19) `[H:abstr_suit(E)] <-> [H:abstr_suit(E)].`

(20) exemplifies some synonymous German adverbs that are used to express a positive attitude to a time or event.

(20a) Der Montag ist *gut/angenehm/günstig/fein/okay* (bei mir/für mich).
(20b) Das ist *gut/angenehm/günstig/schön/okay* (bei mir/für mich).

(21) illustrates that English provides a similar range of positive attitude adverbs that corresponds to the German expressions in (20) as a whole class.

(21a) Monday is *good/convenient/fine/okay/all right* (for me).
(21b) That is *good/convenient/fine/okay/all right* (for me).

For their transfer, attitude adverbials are grouped together w.r.t. the meaning they share. In our domain, it is reasonable to assume the partion in Figure 3, which is implemented by type declarations in (22).

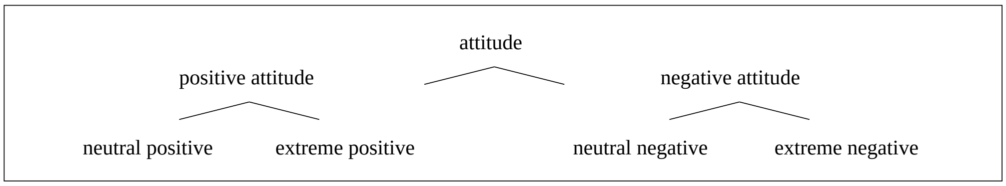

Figure 3: Attitudes

(22)
```
type(de,attitude_adv,[pos_attitude,negative_attitude]).
type(de,positive_attitude,[neutral_pos_attitude,extreme_pos_attitude]).
type(de,negative_attitude,[neutral_neg_attitude,extreme_neg_attitude]).
```

Table 2 and 3 exemplify the corresponding SL and TL lexicalizations for the bilingual predicate types, that are implemented in analogy to (23).[11]

Bilingual Predicate	German Lexicalization
`neutral_pos_attitude`	gut, angenehm, schön, okay, günstig, fein
`extreme_pos_attitude`	toll, wunderbar, ausgezeichnet, perfekt, prima, klasse, hervorragend, super, spitze, ideal, phantastisch
`neutral_neg_attitude`	schwierig, schlecht, ungeschickt, blöd, ungünstig
`extreme_neg_attitude`	übel, unmöglich, ausgeschlossen

Table 2: Domain-Specific Casses of Synonymous Attitude Adverbs in German

(23)
```
type(de,neutral_pos_attitude,[gut,angenehm,schoen,okay,guenstig,fein]).
type(en,neutral_pos_attitude,[good,convenient,fine,okay,allright,suitable]).
```

[11]Getting an extreme positive or negative attitude type as input the generator has also the option to lexicalize it by a combination of an intensifier and an adverb of a neutral attitude type. For the SL part, we allow abstraction only over single predicates.

Bilingual Predicate	English Lexicalization
`neutral_pos_attitude`	good, convenient, fine, okay, allright, suitable
`extreme_pos_attitude`	excellent, wonderful, great, fantastic, perfect
`neutral_neg_attitude`	bad, difficult, inconvenient
`extreme_neg_attitude`	impossible, out, out of the question

Table 3: Domain-Specific Classes of Synonymous Attitude adverbs in English

In contrast to (19), 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, a rule with an bilingual type for these adverbs has to be restricted. The rule in (24a) that captures the examples in (20a) requires that the abstract adverbial predicate is the predicative of the copula.[12] Furthermore, 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. The rule in (24b) covers the case (20b) in which the theme of the attitude was expressed by an event-type pronoun, such as *das* identified by `prontype(I,third,demon)` and *es*, represented as `prontype(I,third,event)`.[13]

The mapping rules for the other bilingual adverbial types are analog to those in (24).

(24a) `[H:neutral_positive_attitude(I)],[unifiable(I,time,S),D:support(E,F), H=<F] <-> [H:neutral_positive_attitude(I)].`

(24b) `[H:neutral_positive_attitude(I)],[D:pron(I),(prontype(I,third,event); prontype(I,third,demon)] <-> [H:neutral_positive_attitude(I)].`

As mentioned above, the generator interprets the verbal predicate `abstr_suit` as an abstraction over attitude verbs and copula constructions with adverbs of the type `neutral_pos_attitude`. It has a theme argument `arg3` and an experiencer

[12]The copula directly embeds the predicative's label. If the predicative is under the scope of an intensifier the copula embeds the label of the intensifier, such that in the transfer rule the coindexation between the copula and the predicative has to be weakened. This is done by a label equation `H=<F`.

[13]Note that it is not sufficient to restrict the instance of the attitude adverb to the sort `temporal`. In case of its attributive use, the range of possible translations is much smaller than in case of its predicative use, e.g. ein *angenehmer* Vormittag - a *pleasant* morning vs. Der Vormittag wäre (mir) *angenehm*. - The morning is *convenient/good/fine* (for me). Hence, the copula has to be anchored in the condition part. With event-type pronouns this constraint is obsolet. There is no alternation between the predicative and attributive use possible, e.g. *ein *angenehmes* das.

argument `arg2`. If, in the TL, a predicative construction is chosen, the `arg3` becomes the subject copula and the `arg2` corresponds to the experiencer PP. This abstraction over different constructions also allows to translate copula constructions with adverbs of the type `neutral_pos_attitude` into attitude verbs, such that (17b) becomes a feasible translation of (20a). On the other hand, it is possible to map adverbs of the type `neutral_neg_attitude` to the negation of the particular attitude verbs (25), besides the mapping to the corresponding TL adverb class.

(25a) Montag ist *schlecht/ungünstig/ungeschickt* bei mir/für mich.
(25b) Monday does *not suit* me /*not work* for me.

The rules in (26) are complex rules that substitute the copula together with its particular kind of predicative and the experiencer to the bilingual predicate `abstr_suit` with an `arg3` which gets the instance of the SL adverb, and an `arg2` which takes the instance of the SL experiencer.[14] This structural change, which is in fact a category switching (see section 5.2), also requires a group manipulation.[15]

(26a)
```
[H:neutral_pos_attitude(I),K:perspective(E,O),D:support(E,F),
del_group_elems([K,D],Y,A)],[unifiable(I,time,S),H=<F]
<-> [H:abstr_suit(E),H:arg2(E,O),H:arg3(E,I),sem_group(Y,[H/A])].
```

(26b)
```
[H:neutral_neg_attitude(I),K:perspective(E,O),D:support(E,F),
del_group_elems([K,D],Y,A)],[unifiable(I,time,S),H=<F]
<-> [H:neg(J),D:abstr_suit(E),D:arg2(E,O),D:arg3(E,I),
sem_group(Z,[D/A]),sem_group(Y,[H]),leq(Z,J)].
```

[14] Note that this mapping presupposes the occurrence of a `perspective` modifier with the copula in order to provide the obligatory `arg2` for the lexicalization with an attitude verb. If it is omitted in the SL, the particular adverbial type is mapped by the less restricted rule (24).

[15] The labels of the predicates `support` and `perspective` are deleted from their group. In (26a) its rest, which contains the labels of all occurring modifiers, is grouped together with the label of the `abstr_suit` predicate in the TL. It keeps the label of the predicative as attachment site for possible intensifiers. In (26b) the situation is more complex since the negation operator is inserted. It keeps the label of the SL predicative for the same reason as above. To anchor the negation, its label `H` is put into a group with the former group label of the copula `Y`. The operator is given scope over the verb with its modifiers by pluggig its hole variable `J` with the corresponding group label `Z`.

4.1.2 Intensifiers

Another example for concept-based mappings is the transfer of intensifiers.

(27a) Das ist *völlig/absolut/voll/vollends* okay für mich.
(27b) This is *completely/absolutely* okay for me.

The examples in (27) illustrate that German and English provide alternative lexicalizations to express an absolute degree of an attitude. Table 4 shows intensifiers that can be grouped together w.r.t. their meaning.

Bilingual Predicate	German Lexicalization	English Lexicalization
`high_grad`	außerordentlich, äußerst, überaus	extremely, exceedingly
`middle_grad`	sehr, ganz	very
`low_grad`	ein bißchen, etwas, ein wenig	a bit, a little
`approx_grad`	zirka, etwa, so, ungefähr	about, approximately
`relative_grad`	recht, ziemlich, relativ	quite, rather, pretty
`absolute_grad`	völlig, absolut, voll, komplett, vollends	completely, absolutely

Table 4: Domain-Specific Classes of Synonymous Intensifiers

The transfer rule in (28) exemplifies how these particular classes of intensifiers are transferred by the use of bilingual types.

(28)
```
[H:absolute_grad(I,A)] <-> [H:absolute_grad(I,A)].
  type(de,absolute_grad,[voellig,absolut,voll_grad,komplett,vollends]).
  type(en,absolute_grad,[complete,absolute]).
```

The mapping of bilingual predicates bears the problem of overgeneration. Regard the Table 5. In German, not every gradual of the type `absolute_grad` can be used with an adverb of the class `emphatic_pos_attitude` (see Table 2). Since the ungrammatical combinations do not occur in the SL, this does not pose a problem for the application of concept-based mappings. But it is crucial for the lexical choice of the generator which has to exclude the incorrect combinations, such as those marked by "*" in Table 6. For cases like these, it is highly complicated to formulate appropriate co-ocurrence restrictions. Probably, it is more promising to use stochastic models that predict possible co-ocurrences.

absolute_grad	emphatic_pos_attitude
*völlig/absolut/*voll/*komplett/*vollends	toll
?völlig/absolut/?voll/*komplett/*vollends	hervorragend
völlig/absolut/voll/*komplett/*vollends	klasse
völlig/absolut/?voll/*komplett/*vollends	ausgezeichnet

Table 5: Co-Ocurrences of Particular German Intensifiers and Attitude Adverbs

absolute_grad	emphatic_pos_attitude
absolutely/*completely	great
absolutely/?completely	wonderful
absolutely/?completely	fantastic
absolutely/*completely	fine

Table 6: Co-Ocurrences of Particular English Intensifiers and Attitude Adverbs

4.1.3 Prepositions

Let us regard the treatment of prepositions to demonstrate another method of concept-based transfer. 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. In order to use the information about prepositional meanings for further disambiguation, the mapping to prepositional concepts can be processed before the actual transfer in a refinement step (see section 3.2.1).

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.[16] 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 (29) and the unspecified spatial interpretation (30) of the *bei*-PP.

(29) Geht/klappt das *bei Ihnen*?
(29a) Does it suit *you*?
(29b) Is it possible *at your place*?

[16] 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).

(30) Das ist schlecht/ungünstig/unmöglich *bei mir*.
(30a) That is bad/inconvenient/impossible *for me*.
(30b) 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,[17] because times – in contrast to events and things – cannot be located in space. Therefore, we provide the refinement rules in (31) and (32) where the sortal constraint `time` on the `arg3` of an attitude verb and on the instance of an attitude adverb forces the perspective reading.

(31)
```
[H:bei(E,X)],[L:abstr_passen(E),L:arg3(E,Y),unifiable(X,person,S1),
 unifiable(Y,time,S2)] <-> [H:perspective(E,X)].
```

(32)
```
[H:bei(E,X)],[G:support(E,F),N:attitude(Y),N=<F,unifiable(X,person,S1),
 unifiable(Y,time,S2)] <-> [H:perspective(E,X)].
```

Let us go back to the examples in (29) and (30). 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. (33) and (34) show the corresponding refinement rules which include the verification of the dialog act `location_da`.[18] A further rule without a dialog act request maps *bei* to `perspective`, which can be regarded as the default interpretation in this context.

(33)
```
[H:bei(E,X)],[L:abstr_passen(E),L:arg3(E,Y),unifiable(X,person,S1),
  R:pron(Y),(prontype(Y,third,demon);prontype(Y,third,event)),
  dialog_act(location_da)] <-> [H:loc_derived(E,X)].
```

(34)
```
[H:bei(E,X)],[G:support(E,F),N:attitude(Y),N=<F,unifiable(X,person,S1),
  R:pron(Y),(prontype(Y,third,demon);prontype(Y,third,event)),
  dialog_act(location_da)] <-> [H:loc_derived(E,X)].
```

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

[18] The dialog act type `location_da` describes all dialog acts of which the topic 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.

Note that the rules in (26) in section 4.1 presuppose that the `perspective` reading of the prepositions *für* and *bei* has already been assigned. Otherwise these mappings would not be feasible.

4.2 Abstraction by Decomposition

Besides generalization, decomposition is a method to abstract away from language-specific lexicalizations. To avoid the well-known problems of constructing an interlingua out of semantic primitives ([Wilks, 1977]), we use decomposition only in restricted domains. Its application in the Verb*mobil* domain seems to be reasonable in the lexical fields of motion verbs (see section 4.2.1) and eating verbs (see section 4.2.2). The elementary units we choose for their decomposed representation meet the requirements of German-English transfer. It is not claimed that they are part of a universal set of conceptual units suitable for purpose-independent decomposition.[19]

Decomposition rules are applied on the SL side in order to provide the same representation for differently structured predications with the same meaning. The predicates obtained by decomposition are transferred by already existing transfer rules.

4.2.1 Movement Events

In Verb*mobil*, we have to treat only a part of the field of motion verbs. Hence, we assume a set of semantic primitives tailored w.r.t. our requirements. We do not subscribe to a particular theory, like those represented in, e.g. [Jackendoff, 1990] or [Kaufmann, 1995]), but take their general ideas into account.

Besides a `move` predicate for the motion itself, we assume a predicate which specifies the instrument of the motion `instr`. The semantic primitive `phase` provides information on whether the beginning, the end or the middle of the movement is focused in the verb's meaning.[20]

The direction of the movement is, in most cases, expressed by prepositions or locational adverbs. They are assigned a conceptual relation, such as `goal`, `source` or `path` by another set of monolingual refinement rules, see section 4.1.3. However, in some cases, the direction is incorporated in the verb's meaning, e.g. *hinfliegen* ('to fly there'), such that the component of direction has to be included in the verb's decomposition rule, see (37). This makes it possible to

[19] For problems connected with this task, see e.g. [Fodor, 1970], [Fodor et al., 1980] and [Jackendoff, 1990]).

[20] For other domains, it might be necessary to have an additional predicate `mood` which distinguishes e.g. *to walk* from *to dance*; we do without it because it is not relevant for meeting scheduling dialogs.

provide the generator with the same represenatation for incorporated direction and direction expressed by a modifier.[21]

Motion verbs are decomposed into as many relations as are necessary to catch their meaning; that means that the number of semantic primitives is variing from verb to verb, see the examples in (35) - (37).

(35) `[H:fliegen(E)] <-> [H:move(E),H1:instr(E,F),H2:udef(F,G),H3:plane(F), H4:phase(E,middle),sem_group(G,[H3])].`

(36) `[H:landen(E)] <-> [H:move(E),H1:instr(E,F),H2:udef(F,G),H3:plane(F), H4:phase(E,end),sem_group(G,[H3])].`

(37) `[H:hinfliegen(E)] <-> [H:move(E),H1:instr(E,F),H2:udef(F,G1),H3:plane(F), H4:phase(E,middle),H5:loc_int(E,X),dir(H5,yes),H6:demonstrative(X,G2), H7:abstr_loc(X),sem_group(G1,[H3]),sem_group(G2,[H7])].`[22]

By applying these kinds of decomposition rules, we obtain a common representation for all of the sentences in (38), which means for the generation more freedom in lexical choice.

(38a) Ich denke, dass Paul am Montag *hinfliegt*.
Ich denke, Paul *fliegt* am Montag *dahin*.

(38b) I think Paul will *fly there* on Monday.
I think Paul will *go there by plane* on Monday.

4.2.2 Eating Events

In the domain of meeting scheduling, expressions denoting an eating situation at a specific time occur quite frequently, see the examples in (39).

(39a) Wir könnten am Montag gemeinsam *zu Abend essen/abendessen/ das Abendessen einnehmen*.

(39b) On Monday we could *dine/have dinner* together.

[21]To achieve an identical semantic representation, the obtained semantic primitives are analysed as modifiers.

[22]The incorporated `goal` expressed by the prefix *hin* is represented as a prepositional predicate with an underspecified internal argument. The direction is covered by `H5:loc_int(E,X)` (localization in the interior of something) and the directionality information `dir(H5,yes)`, which makes the location to the endpoint of the motion. The internal argument of the prepositional predicate is represented as `H6:demonstrative(X,G2),H7:abstr_loc(X),H9:sem_group(G2,H7)` which refers to a not further specified spatial region.

Verbal predicates which include the mode of eating (e.g. *to nibble*) or other aspects connected with eating (e.g. *to feast*) are nearly never used in the Verb*mobil* domain. For that reason, it is sufficient to assume as elementary units for decomposition a predicate `dc_eat` for the situation of eating itself and another one `dc_time` which fixes the time of the meal.

(40)
```
[H:abendessen(E),add_to_group(H1,H)]
 <-> [H:dc_eat(E),H1:dc_time(E,evening)]
```

(41)
```
[H:essen(E),H1:zu(E,I),H2:udef(I,G),H3:abend(I),sem_group(G,[H3])]
 <-> [H:dc_eat(E),H1:dc_time(E,evening)].
```

(42)
```
[H:einnehmen(E),H:arg3(E,I),H1:def(I,G1),H2:abendessen(I),
 sem_group(G1,[H2]),add_to_group(H3,H)]
 <-> [H:dc_eat(E),H3:dc_time(E,evening)].
```

By applying the monolingual decomposition rules in (40) - (42),[23] we get the same representation for *abendessen, das Abendessen einnehmen* and *zu Abend essen* on the German side. The generation has the option to choose between *to dine* and *to have dinner*.

[23] In (40) we have to add the label of the time expression to the group of the verbal predicate. (41) deletes the whole NP in the `arg3` role including the group introduced by the definite article. The operations in (42) are similar to that in (42). Here, in addition, the label of the time predicate has to be put into the corresponding group.

5 Semantic-based Transfer

At the semantic level, many structural divergences ([Dorr, 1993] [Dorr, 1994]) are neuralized. However, some of them remain to be bridged at this level of abstraction, such as changes in the argument structure, head and category switching (see section 5.1 and 5.2) as well as incorporation (see section 5.3). In the following, we address the treatment of these phenomenona.

5.1 Head Switching

Head switching occurs with a couple of attitude adverbs, such as *gerne* ('to like to'), *ungern* ('to do not like to'), *lieber* ('to prefer'), *eher* ('to prefer') or *zufällig* ('to happen to'). Let us regard the treatment of this divergence by the example in (43). Here, the meaning of the German modifier *lieber* - the comparative form of *lieb* ('good') - corresponds to the English modality state of *preferring*. The rule for this kind of restructuring is shown in (44).

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

(44)
```
[F:lieb(I),F:comp(I,_,_),del_group_elem(F,G,R),ta_mood(I,X),
 ta_tense(I,Y)],[J:rel(verb,I),J:arg1(I,B),not(sent_mood(imp))]
 <-> [F:prefer(E),F:arg1(E,B),F:arg3(E,H),ta_mood(E,X),
 ta_tense(E,Y),sem_group(G1,R),sem_group(G,[F]),leq(G1,H)].
```

Prefer is a control verb which embeds the situation modified by *lieber* in the SL as its `arg3`.[24] The idea is to abstract away from the concrete situation by anchoring its semantic class `verb` in the 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` predicates are handed over from the German verb's instance to the instance of `prefer`. As we will show in section 6.6, sentence mood has an influence on the translation of *lieber*. The translation with the verb *to like* is allowed only in declarative and interrogative sentences. Thus, the rule is restricted w.r.t. the sentence mood.[25]

[24] The propositional embedding expressed via the hole variable is constrained by the corresponding `leq` statement.

[25] Head switching goes along with some operations on the groupings in order to restore the corresponding scope relations. Here, the label of the modifier `F` is taken out of its group `G`. This group label is given to the control verb's label `F` (`sem_group(G,[F])`), in order to hang all operators that had scope over the SL's main verb above the introduced control verb `prefer`. The list of the remaining SL modifier labels `R` is assigned the group label `G1` of the embedded verb in the TL.

5.2 Category Switching

Some categorial changes between the SL and the TL ([Dorr, 1994]) show a reflection at the semantic level. We demonstrate this by the the switch of a predicative into a verbal construction which is quite frequent phenomenon. Regard the example in (45).[26]

(45) Mir wäre ein Termin am Morgen eigentlich *lieber*.
Actually, I *prefer* an appointment in the morning.

(46)
```
[H:lieb(I),H:comp(I,_,_),P:support(K,H1),T:perspective(K,M),
 del_group_elems([P,T],G,R)],[H=<H1] <-> H:prefer(K),H:arg1(K,M),
 H:arg3(K,I),sem_group(G,[H/R])].
```

The rule in (26) substitutes the predicate `support` together with its decomposed predicative `lieb`, `comp` and the `perspective` modifier by the verbal predicate `prefer`, the latter becoming the verb's `arg1`. Since the instance of the copula is shared by the TL verb, tense and mood values need not be transferred. In order to give a gradual that might occur above the predicative scope over the verbal predicate in the TL, we use the same label for `lieb` and `prefer`.[27]

5.3 Incorporation

Incorporation is a cross-lingustic phenomenon, which can be observed quite frequently ([Baker, 1988]). Negation, mood, direction and verbal arguments might be contained in the meaning of a verbal predicate in one language but not in the other. To bridge these kinds of divergences in the semantic structure of the involved languages, we have to provide rules that in- or excorporate the corresponding elements of meaning.

5.3.1 Incorporation of Negation

Incorporated negation, e.g. expressed by a prefix, and its excorporated counterpart are often equally conventionalized in two languages, see (47).

(47) Da werde ich leider *abwesend/nicht anwesend* sein.
Unfortunately, I will *be absent/not be present* then.

[26] For more examples, see the rules in (26) in section 4.1.1.

[27] This requires the restructuring of the groupings. The labels of `support` and `perspective` are taken out of their group `G`, whose rest `R` is concatenated with the verb's label `H` in the TL.

In order to capture the synonymy of the two ways of expression, the sentences in (47) are assigned the same semantic structure. As neutral representation, we choose the one with the explicit negation. Thus, the generation has the alternative to select between the one or the other lexicalization.

The monolingual rule in (48) shows the restructuring of the SL semantic structure of *abwesend* into *nicht anwesend* in the context of the copula. [28]

(48)
```
[F:abwesend(E),del_group_elem(L,G,Ls)],[L:support(I,K),F=<K]
 <-> [F:neg(A,H),F:anwesend(E), leq(G1,H),sem_group(G,F),
 sem_group(G1,[L/Ls)].
```

In other cases, the meaning of a negative prefix has to be excorporated since the TL does not provide a similar way of expression. Regard example (49).

(49) Ich würde *ungern* mein Seminar ausfallen lassen.
I do *not like* to cancel my seminar.

If *ungern* modifies a verb, it undergoes head switching in its English translation (see section 5.1). In the TL the new main verb *like* occurs under the scope of negation, i.e. the negation corresponds to the prefix *un-* of *ungern*. (50) shows the rule which combines head switching with the excorporation of negation.[29]

(50)
```
[Z:ungern(I),ta_mood(I,X),ta_tense(I,C),del_group_elem(Z,G,R)],
[J:rel(verb,I),J:arg1(I,B)] <-> [Z:neg(Y),D:like(E),D:arg2(E,B),
 D:arg3(E,H),ta_mood(E,X),ta_tense(E,C),sem_group(G,Z),
 sem_group(G2,D),leq(G2,Y),sem_group(G1,R),leq(G1,H),leq(G1,Y)].
```

5.3.2 Incorporation of Mood

German and English also differ w.r.t. whether mood information is contained in the meaning of a verb or expressed by an modifier, see (51).

(51) Das sollten wir *fest abmachen/ansetzen/vereinbaren/einplanen/ausmachen.*
We should *fix* that.

---

[28] The group label of the support construction G is given to the negation in order to bound it above. The negation is given scope over the group G1 that collects the labels formerly contained in G.

[29] For explanation of the restructuring of the scope and grouping relations, see the discussion on example (88) in section 6.2 and that of the rule (44) in section 5.1.

While the English verb *to fix* means to arrange something for sure, in German, one has to use a verb denoting an arrangement with the adverbial modifier *fest* ('firmly/definitely') in order to emphasize the definitness of a meeting or a time. I.e. for translation, we have to merge these verbs and the modifier *fest*. Since this transformation holds for a whole class of German verbs, we introduce in (51) the type `abstr_arrangieren`. The corresponding rule is shown in (53).[30]

(52)
```
type(de,abstr_arrangieren,[abmachen,ansetzen,vereinbaren,einplanen,
  ausmachen,planen]).
```

(53)
```
[H:fest(E),R:abstr_arrangieren(E),del_group_elem(H,G,Z)],[R:arg3(E,I),
  unifiable(I,temporal,S1)] <-> [H:fix(E),sem_group(G,Z),eq(H,R)].
```

5.3.3 Incorporation of Direction

Information concerning direction - usually expressed by a preposition or a locational adverb - is sometimes part of the meaning of a verb, see (54).

(54) *Gehen* Sie einfach *in* das erste Zimmer auf der rechten Seite.
Just *enter* the first room on the right.

Enter describes a movement into a location with boundaries. The German *gehen* ('to go') denotes the motion without a specification of the direction. If modified by the preposition *in* with an internal argument of the sort `nongeo location` the meaning of *gehen* is synonymous with that of *enter*. This is captured by the rule in (55):

(55)
```
[H:gehen(E),H1:in(E,X),del_group_elem(H1,G,R)],
[unifiable(X,nongeo_location,S)]
 <-> [H:enter(E),H:arg3(E,X),sem_group(G,R)].
```

5.3.4 Incorporation of Arguments

In (56) the prefix *ver-* in *verwählen* ('to dial the wrong number') contributes the same meaning as *die falsche Nummer* ('the wrong number') - the argument of *wählen* ('to dial').

[30] All operators above `fest` and `abstr_arrangieren` have to be put above `fix` in the TL; this is done by the predicate `eq` ('equal') which equates the corresponding labels.

(56) Da habe ich mich offensichtlich *verwählt*.
Da habe ich offensichtlich *die falsche Nummer gewählt*.
I obviously *dialed the wrong number*.

In English, there is no such alternative: the meaning of the argument *wrong number* can't be captured by a prefix to the verb *dial*.[31] For this reason, we introduce the complex rule in (57). It decomposes `verwählen` into its morphological stem which is translated by `dial` and a list of predicates that substitutes the prefix *ver-*. It fills the `arg3` position of `dial` with the intersective modifier `wrong` and its modificandum `number` which is under the scope of a definite article.

(57)
```
[H:verwaehlen(E)] <-> [H:dial(E),H:arg3(E,X),H1:number(X),
 H2:wrong(X),H3:def(X,G,_),sem_group(G,[H1,H2]).]
```

5.4 Reduction

Reduction is one of the major strategies in human interpretation ([Prahl, 1994b]). An interpreter does not translate an utterance word by word, reproducing all the speaker's hesitations, interruptions or repetations. Follwing Grice's principles of relevance, quantity and quality ([Grice, 1975]), the interpreter selects the information which is necessary in order to transmit the communicative goal of the utterance to the hearer. I.e. she or he intervenes into the dialog by cutting down the uttered input to the relevant information. This concerns the propositional as well as the illocutional content of an utterance.

To simulate this, let us call it *global reduction* strategy, an MT system has to detect hestitations, interruptions, repetitions, etc., beyond the borders of an utterance. This is, at the time being, a topic of future research.

At the present state of the art, it seems to be more realistic to discover cases of reduction, which are traceable within the boundaries of an utterance. Let us call this *local reduction*. Here, the deletion of information is justified by the following reasons:

- Minimization the redundancy (see section 5.4.1 and 5.4.4)
- Stylistic well-formedness of the TL (see section 5.4.2)
- Grammatical well-formedness of the TL (see sections 5.4.3)

[31] There exists a direct translation of *verwählen* with *misdial* which is not in common use anymore.

For local reduction, besides the decrease of redundancy (which is a language-independent problem), TL inherent requirements come into play. For example, compared with German, English has an impoverished use of discourse particles and filler words. Consequently, particles are often dropped in order to achieve a stylistic well-formed English translation ([Alexandersson and Ripplinger, 1996]).

However, the elimination of linguistic elements during transfer is a delicate matter, since predicates that provide information essential for achieving the communicative goal could get lost. The crucial point is the identification of the particular contexts in which the dropping is allowed.

In the following, we show some examples of context-sensitive local reduction.

5.4.1 Deicic Reference to the Extra-Linguistic Context

Deictic adverbs, such as *hier* ('here'), *dort* ('there) or *da* ('there, then'), can be used to refer either to something in the extra-linguistic context (58) or they have their antecedent in the linguistic context (60)-(63). In both cases, the information provided by these kinds of adverbs can be redundant, which allows their elemination in the translation.

(58a) Ich bin *hier* am Dienstag vormittag schon ausgebucht.
I am already booked up on Tuesday morning.

(58b) Sollen wir es gleich *hier* in der ersten Woche machen?
Should we just make it this week?

Regard the examples in (58). By using *hier* in front of the temporal PP, the speaker actually points to a spot in the diary, i.e. we are faced with a reference to the object of the speaker's activity which accompanies his utterance.[32] A human interpreter does not translate *hier* in (58), since the reference to a column in the calender does not contribute to the communicative aim of the utterance.

Now, it remains to determine the context in which the information conveyed by *hier* in (58) is obsolet. One necessary condition to capture this use concerns the order of the adverb and the preposition: *hier* must be immediately followed by a temporal PP. Unfortunately, the semantic representation does not reflect the surface word order. But, even if this information we would be reflected in terms of information structure, it is not sufficient to allow the deletion of *hier*. In a lot of contexts, especially if used with attitude expressions (see section 4.1.1), the reference ambiguity of *hier* remains. Regard the example in (59).

[32]This way, the speaker lets the hearer know that she or he is looking up a calender, such that a possible break between a request and a suggestion gets an explanation to the hearer.

(59) Es ginge *hier* am Dienstag.
(59a) *Here* it would be possible on Tuesday.
(59b) It would be possible on Tuesday.

In our opinion, without further context it is impossible to distinguish between the two possible interpretations of (59), which force the translations in (59a) and (59b). The problem is that *hier* as a modifier of an attitude predication can always refer to the place associated with the speaker. Even in case, there is already another locative expression in the same utterance, *hier* not necessarily refers to the diary. It can be used to make the spatial specification more explicit, as in (62). And then its deletion would mean a loss of information. [33]

However, other cases are less discouraging. Regard the examples in (60). They demonstrate a similar effect: *hier* refers to the diary. The difference is that the antecedent - the diary - is explicitly mentioned in the linguistic context.

(60a) Den Termin habe ich *hier* in meinem Kalender notiert.
I have made a note of that appointment in my diary.

(60b) Wie ich das *hier* auf dem Terminplaner sehe, wäre März ganz gut.
As far as I can see in the diary, March would be quite allright.

In our opinion, the reason for dropping *hier* in (60) is the redundancy of the provided information. Being in a meeting scheduling situation, the participants share some standard assumptions ([Prahl, 1994a]). They know that one usally looks up a diary, and when looking it up, it is clear that it must be located next to its user. Thus, a further specification of the calender's location to the speakers place by the use of *hier* is not necessary. This leads to the rule in (61), where the deletion is restricted to a couple of prepositions used to focus a predicate of the sort `info_bearer`.[34]

(61)
```
[H:hier(E),del_group_elem(H,G,R)],[(K:in(E,I);(K:anhand(E,I);
K:auf(E,I)),unifiable(I,info_bearer,S1)] <-> [sem_group(G,R)].
```

[33] Without going into details, we found out that further information, such as B3 boundaries, speech act information, or standard assumptions about the reference of deictic anaphors in meeting scheduling situations might help in some contexts, but they are not sufficient to provide a general disambiguation strategy for all occurrences of this kind. This is probably a case, where the use of non-verbal information is more promising.

[34] The deletion of a modifier goes along with the removal of its label from its group, i.e. `del_group_elem(H,G,R)` removes the label `H` of `hier` from the group with label `G` and `sem_group(G,R)` inserts this group into the TL VIT with the rest list `R`.

Consider the examples in (62). Although used in a quite similar context as in (60), *hier* in (62) has to be translated since it provides information important to the hearer: the spatial region denoted by the adverb or the preposition gets restricted to the speaker's current location.[35] This translation is produced compositionally by the corresponding standard rules.

(62a) Wir könnten uns *hier* gegenüber in der Cafeteria treffen.
We could meet in the cafeteria opposite from *here*.

(62b) Wir sollten uns *hier* in der Uni treffen.
We should meet *here* at the university.

Finally, let us regard the examples in (63), where *hier* has the same deictic locational function as in (62), but, in this case, it gets not translated. Here, the maximally possible precision is contributed by the demonstrative *dies* ('this'), i.e. the reference to the location is already unambiguous, such that *hier* can be dropped for the reason of redundancy.

(63a) Wir treffen uns *hier* in *diesem* Zimmer.
We'll meet in this room.

(63b) Kommen sie in den Seminarraum *hier* auf *dieser* Etage.
Come to the seminar room on this floor.

This redundancy of *hier* is fixed in (64) which differs from the rule in (61) by the additional restriction on the occurrence of a demonstrative.[36].

(64)
```
[H:hier(E),del_group_elem(H,G,R)],[K:loc_prep(E,I),dir(K,no)
unifiable(I,location,S1),L:demonstratative(I,Y),demontype(I,near)]
<-> [sem_group(G,R)].
```

5.4.2 Approximative Time Expressions

To approximate a time point, particular time expressions are used with gradual particles, such as *so*, *ungefähr*, *zirka* oder *etwa*, which all mean *approximately*, see (65) and (66).

[35] Even if *hier* focuses a locative PP with a proper name, see *Hier* in Berlin finden wir immer eine gute Kneipe. ('Here in Berlin, we'll always find a nice pub.'), the information contributed by this adverb is not redundant. It tells where the speaker is currently staying.

[36] For the analysis of demonstratives, see ([Bos et al., 1996a])

(65) Montag früh *zirka/etwa/so/ungefähr* **um** neun wäre mir recht.
Monday morning *around* nine would suit me.

(66) Ich bin dann *zirka/etwa/so/ungefähr* **ab** drei Uhr da.
I'll be there *approximately* **from** three o'clock **on**.
I'll be there **from** *about* three o'clock **on**.

In case the gradual has scope over a temporal prepositions with a punctual interpretation, like *in*, *an*, *gegen* and *um*, the stylistically preferred English translation is *around*, see (65). This preposition merges the meaning of approximativity and location in time contributed by the SL gradual and preposition respectively. Note that deictic temporal prepositions, such as *vor* ('before'), *ab* ('from'), *seit* ('since') or *nach* ('after') do not allow this kind of reduced translation, see (66). By the deletion of these prepositions, information would get lost, which is not the case for the mentioned topological prepositions.[37]

The rule that captures the reduction examplified in (65) is shown in (67). By referring to the predicate types `approx_grad` which abstracts over the various approximative particles (for its definition, see (15) in section 3.2.3) and `punct_tprep`, which clusters all punctual temporal prepositions (67), we gain a maximal degree of generalization. In case a deictic temporal preposition is used with the gradual (66), the translation remains compositional.

(67)
```
[M:approx_grad(H),H:punct_tprep(I,A)],[unifiable(A,time,S1)]
<-> [M:around(I,A)].
type(de,punct_tprep,[an,in,zu,gegen,um,tloc]).
```

Sometimes , spoken German displays sequences of approximative graduals (68) that have to be deleted in the TL. The corresponding reduction rule which puts all these particles and the preposition together is shown in (69).

(68) Ich komme *so ungefähr* **um** zehn.
I'll come *arround* zehn.

(69)
```
[K:approx_grad(L),L:approx_grad(H),H:punct_tprep(I,A)],
[unifiable(A,time,S1)] <-> [K:around(I,A)].
```

[37] For the distinction between deictic and topological prepositions, see [Herskovits, 1986].

5.4.3 Merging of Locational Modifiers

Finally, let us regard with (70) and (71) a case, where the TL requires to compress the information realized by a sequence of locational modifiers in the SL.[38]

(70) Machen wir es doch *bei mir im Büro.*
Let's do it *in my office.*

(71) Gut, dann komme ich *zu ihnen ins Büro.*
Well, I'll come *to your office* then.

(70) and (71) exemplify a different distribution of information in German and English. In the SL, the prepositions *bei* ('at') and its directional counterpart *zu* ('to') with an internal argument that refers to a human being introduce a relatively unspecified spatial region.[39] It denotes the place associated with that person in a particular situation ([Buschbeck-Wolf, 1995]). The following static (70) and directional (71) preposition *in* ('in, to') refers to the interior of a location, which is in our example an office. In the TL, the two prepositions *bei* and static *in* in (70), and *zu* and directional *in* in (71), are reduced to the one with the more specific meaning. The TL prepositions *in* and *to* have a location - the office - modified by a possessive pronoun with speaker or hearer reference as internal argument. Thus, the TL PP denotes the intersection of the two regions introduced in the SL.

This translation requires the inference that the considered location is the speakers location. Given the dialog situation, it can be motivated, on the one hand, by the participants' standard assumptions which include the knowledge about the speakers place, about the location one usually meets, etc. On the other hand, following Grice's principle of cooperativity ([Grice, 1975]), a cooperative speaker would not suggest two incompatiple places in a row. After having given a rough spatial description, she or he would usually refine it further by providing more information.

(72)
```
[H:bei(E,X),del_group_elem(H,G,R),add_to_group(J,H2),dir(H,no)],
[L:loc_prep(E,Y),dir(L,no),H\==L,unifiable(Y,nongeo_location,S1),
 unifiable(X,person,S2),H3:def(Y,G1),H2:rel(noun,Y)]
 <-> [J:poss(Y,X),sem_group(G,R),demontype(Y,spec)].
```

[38] While (70) and (71) are completly fine in German, their literal translations into: 'Let's do it *at my place in the office.*' or 'Well, I'll come *to you to the office* then.' sound odd.

[39] In case of the preposition *zu*, this region is the endpoint of a motion.

(73)
```
[H:zu(E,X),del_group_elem(H,G,R),add_to_group(J,H2),dir(H,yes)],
[L:loc_prep(E,Y),dir(L,yes),H\==L,unifiable(Y,nongeo_location,S1),
 unifiable(X,person,S2),H3:def(Y,G1),H2:rel(noun,Y)]
 <-> [J:poss(Y,X),sem_group(G,R),demontype(Y,spec)].
```

The rules in (72) and (73) show the implementation of this kind of restructuring. The preposition with the less specific meaning, i.e. `bei` and `zu` respectively, is substituted together with its (non)directionality information by the underspecified possessive relation `poss` (see section 2.2) under the following condition: the internal argument of the preposition to be deleted refers to a person. There is a further non(directional) preposition of the type `loc_prep` with the same external argument (`E`) in its context.[40]

5.4.4 Redundancy in the Argument Structure

Languages may differ w.r.t. the acceptable degree of redundancy of optional arguments. We exemplify this with the verbs *vorstellen* vs. *to introduce*:

(74) Darf ich mich *Ihnen* vorstellen?
*May I introduce myself *to you*?
May I introduce myself?

In German, it is possible to specify to whom one wants to introduce even if it is obvious from the situation, such as in a face-to-face communication. Since the addressee of the utterance is the hearer, this information is redundant. This seems to be the explanation for the elemination of the optional argument of *vorstellen* its English translation, see (74).

The situation is different with *danken* vs. *to thank*. In a dialog situation, a German speaker does not have to realize the `arg2` syntactically if the addressee of the thank is the hearer, see (75). In English, however, this argument is obligatory.

(75) Ich danke für Ihre Hilfe.
*I thank for your help.
I thank *you* for your help.

[40]Since this rule can be generalized, see: *zu mir an's* Hotel - *to my* hotel, *bei uns vor* der Firma - *in front of our* company, we make use of the type `loc_prep`, which groups together all locative prepositions. For our domain, it is adequat to restrict their internal argument to the sort `nongeo_location`. Since the prepositions with the unspecific meaning also belong to the class `loc_prep`, we have to explicitly exclude the label identity in the condition part. All other predicates are used to restore the group and scope relations.

It seems to be unpredictable how much redundancy in argument structure a language allows or even demands (at least there seems to be no answer to that question so far). Therefore, one has to specify a rule for each verb concerned.

(76)
```
[H:vorstellen(E),H:arg2(E,X),H2:pron(X),prontype(X,he,std),
 num(X,sg),cas(X,_),pers(X,_)],[H:arg1(E,Y),prontype(Y,sp,std)]
 <-> [H:introduce_to(E)].
```

The `arg2` deletion for the example in (74) is shown in (76). The addressee of *vorstellen* is not transferred into English if the `arg2` refers to the hearer (`prontype(X,he,std)`) and the `arg1` to the speaker (`prontype(X,sp,std)`).[41]

In contrast, the rule in (77) inserts an addressee for *to thank*, which is in the Verb*mobil* domain by default the hearer. Note that the rule is only applicable if the optional arg2 is not realized in the SL.

(77)
```
[H:danken_fuer(E),H:arg3(E,X),add_to_group(H1,H)],[not(H:arg2(E,Y)]
 <-> [H:thank(E),H1:for(E,X),H:arg2(E,Y),H2:pron(Y),num(Y,sg),
 prontype(Y,he,std)].
```

5.5 Phrasal Translation

For idioms - expressions whose meaning is not compositional - one has to formulate rules whose LHS covers the hole expression. Even for idioms it might be neccessary to formulate contextual restrictions to identify the correct translation. E.g. the expression *ins Haus stehen* is usually translated into *to be coming up* (78). However, occurring with a dative NP[42], one would rather choose an expression of the type *somebody is facing something* as translation (79).

(78) Viel Arbeit *steht ins Haus.*
Plenty of work *is coming up.*

(79) Im Juni *stehen* mir drei Treffen *ins Haus.*
In June I'm *facing* three meetings.

In German, it is also possible to modify the idiom by time span expressions with the preposition *seit* ('since'). In this context, the translation *something is*

[41] By removing the pronoun with hearer reference, all information connected with it, i.e. its number (`num`), person (`pers`) and case (`cas`) features are eliminated as well.

[42] It is semantically represented as a `perspective` modifier.

coming up since a while sounds odd. One would rather translate it into *something is scheduled since a while* (79).

(80) Seit Tagen *steht* eine Besprechung *ins Haus*.
A meeting *is scheduled* since a couple of days.

Therefore, one needs the three rules in (81) - (83) to translate the idiom *ins Haus stehen*, each of which has (at least) the whole idiom as its LHS.

(81)
```
[H:stehen(E),H2:in(E,X),H3:haus(X),_:def(X,G1),H:arg3(E,Y),num(X,_),
 cas(X,_),pers(X,_),del_group_elems([H2,H],G,R),sem_group(G1,[H3])]
 <-> [H1:support(E,H),H:coming_up(Y),sem_group(G,[H1/R])].
```

(82)
```
[H:stehen(E),H1:in(E,X),H3:haus(X),H2:perspective(E,Y),num(X,_),cas(X,_),
 pers(X,_),C:def(X,G1),del_group_elems([H1,H2],G,R),sem_group(G1,[H3])],
 <-> [H:face(E),H:arg2(E,Y),sem_group(G,R)].
```

(83)
```
[H:stehen(E),H2:in(E,X),H3:haus(X),_:def(X,G1),H:arg3(E,Y),num(X,_),
  cas(X,_),pers(X,_)del_group_elems([H2,H],G,R),sem_group(G1,[H3])],
 [T:seit(E,K)] <-> [H1:support(E,H),H:schedule(E1),H:arg3(E1,Y),
  ta_tense(E,perf),sem_group(G,[H1/R])].
```

6 Ambiguity Resolution in Transfer

Besides the higher mapping level, semantic transfer has the advantage that many SL specific ambiguities, which force different translations, are already resolved in the analysis, since they require different semantic interpretations. In the Verb*mobil* domain these are among others the following systematic ambiguities between semantic classes:

- Ambiguities between graduals and intersective modifiers
  E.g. *voll* ('completely', 'full'), *so* ('approximatly', 'like that')
- Ambiguities between pragmatic adverbs and intersective modifiers
  E.g. *ruhig* ('just', 'quiet') or *natürlich* ('of course', 'natural')
- Ambiguities between quantifiers and temporal adverbs
  E.g. *vormittags* ('in the morning', 'every morning'), *montags* ('on Monday', 'every Monday')

However, a lot of translational ambiguities remains within a semantic class. They are resolved in the transfer component. In the following, we give an overview over the various types of contextual constaints that we use for disambiguation. For demonstration and simplicity, we isolate them and present only minimal pairs of transfer rules that map onto different TL predicates.

6.1 Sorts

Many translational ambiguities can be resolved by sortal constraints: the particular readings of a verb are identified by sortal restrictions on its arguments, the meanings of a preposition are recognized by the sort of its internal argument, see [Buschbeck-Wolf and Nübel, 1995], and adverbial and adjectivial modifiers are disambiguated by sortal constraints on their instance.

The sortal information is assigned to referential predicates in the VIT representation (see section 2.1). Sorts are defined in the sort hierarchy (see Figure 4 in the Appendix) that is encoded in CUF ([Dörre et al., 1994]). It presents a common ontological categorization which includes first of all domain relevant entities. The granularity of sorts and the partition of the hierarchy meet the particular disambiguation requirements.

We demonstrate the use of sortal constraints by the transfer of the predicate *groß* which has a literal as well as a metaphorical meaning. It is used literally (84), if it modifies concrete things that have a spatial dimension. If the modified predicate refers to a non-concrete entity its collocational use (85) is identified.

(84a)	ein *großer* Mann	-	a *tall* man
(84b)	ein *großes* Zimmer	-	a *large* room
(84c)	ein *großes* Auto	-	a *big* car

(85a)	eine *große* Freude	-	a *great* pleasure
(85b)	eine *große* Hitze	-	a *severe* heat
(85c)	eine *große* Geschwindigkeit	-	a *high* speed
(85d)	ein *großes* Problem	-	a *big* problem
(85e)	ein *großes* Gefühl	-	a *strong* feeling
(85f)	eine *große* Entdeckung	-	a *great* discovery
(85g)	eine *große* Pause	-	a *long* break

In (84) *groß* expresses that the particular objects have a large spatial extention. In (85) it describes a high degree on a scale that is inherent to the modified entity. For properties such as pleasure, heat or speed, and for abstract concepts, such as problem or feeling, this is a high intensity (85a) - (85e). For events, such as a discovery, an invention or a symophony, *groß* emphasizes their importance (85d). With time intervals, such as a break or a journery, it refers to their temporal extension which leads to the translation into *long* (85g).

The transfer of *groß* in its literal meaning is captured by regular mappings (86a) - (86c). It is translated into *tall* if the object it refers to has a dominant vertical dimension. Here, English forces a specialization. Since, in our domain, this property is only relevant for people the sort is restricted correspondingly (86a). If a location, i.e. its volume or square, is characterized as being *groß* the preferred English correspondence is *large* (86b). For all other concrete things we assume *big* to be its standard translation (86c).

(86a) `[H:gross(E)],[unifiable(E,human,S)] <-> [H:tall(E)].`

(86b) `[H:gross(E)],[unifiable(E,location,S)] <-> [H:large(E)].`

(86c) `[H:gross(E)],[unifiable(E,thing,S)] <-> [H:big(E)].`

The translation of *groß* in its collocational usage is very idiosyncratic. To avoid a large amount of highly specific mapping rules we prefer to introduce the abstract predicate `high_degree` that captures the high intensity meaning (87), and is lexicalized w.r.t. the particular TL noun it is applied to.[43] This kind of abstraction (see section 4.1) can be compared to lexical functions for adjectives in collocative use (see [Melchuk et al., 1984]).

[43] This predicate is also assigned to other adjectives with the same interpretation, see [Abb and Buschbeck-Wolf, 1995].

(87) `[H:gross(E)],[unifiable(E,abstract,S)] <-> [H:high_degree(E)].`

6.2 Abstract Predicates

Abstract types (see section 3.2.3) are also used to constrain transfer mappings in an efficient way.

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

(88) exemplifies a problem with the translation of the predicate *schlecht* in cases where it modifies verbs expressing a positive attitude.[44] 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 attitude verb has to be put under the scope of negation, see (89). For this mapping, the modified relation is represented by the predicate type `abstr_suit` in the condition part to restrict the mapping to the relevant context.[45] In contrast to our analysis, [Copestake et al., 1995] propose an context-free rule 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 co-ocurence restrictions.

(89)
```
[L:schlecht(I),del_group_elem(L,G,Ls)],[M:abstr_passen(I)] <->
[L:neg(H),L1:good(I),leq(G1,H),sem_group(G,L),sem_group(G1,[L1/Ls)].
```

6.3 Predicate Types

The particular type of a predicate might also be decisive to determine the appropriate TL correspondence. Predicate types are abstractions over the semantic classes used in the semantic construction. In a way, they correspond to the main grammatical categories, such as prepositions, verbs, nouns, etc.

[44] See also: Das paßt/geht/klappt bei mir *unmöglich*. - That does *not* suit me /work for me."

[45] The label of `schlecht` is taken out of its group, whose group label `G` is handed over to the negation in order to bound the operators above. The negation itself is given scope over the group that contains the verb's label together with the labels of its modifiers, including the one of `good`.

(90a) Das ist ein *kurzfristiger* Termin.
This is a *quick* appointment.

(90b) Wir vereinbaren diesen Termin *kurzfristig*.
We'll arrange this appointment *at short notice*.

(90c) Der Termin ist mir zu *kurzfristig*.
This appointment is too *soon* for me.

(90) shows that the translation of *kurzfristig* depends on whether it is used as an adjectival modifier (90a), an adverbial modifier (90b) or as predicative of the copula (90c). Since in our semantic representation, intersective adjectives, intersective adverbs and predicatives share the same semantic representation ([Abb and Maienborn, 1994]),[46] the particular usage has to be recovered in the transfer rule. In (91a) and (91b) this is achieved by specifing the type of the modifier (i.e. `noun` and `verb`). In (91c), the condition part fixes the predicative use, i.e. the label of `kurzfristig` must be directly or indirectly embedded by the predicate `support`.

(91a) `[H:kurzfristig(E)],[H1:rel(noun,E)] <-> [H:quick(E)].`

(91b) `[H:kurzfristig(E)],[H1:rel(verb,E)] <-> [H:at(E,X),`
`F:udef(X,G,_),M:notice(X),J:short(X),sem_group(G,[M,J])].`

(91c) `[H:kurzfristig(E)],[F:support(I,K),H=<K] <-> [H:soon(E)].`

This example shows that, in some cases, syntactic information which is not reflected in the semantic representation has to be recovered for disambiguation. In order to keep semantic transfer completely free from syntactic information, we would need an abstraction over the modifier and predicative use of *kurzfristig*. Then, the selection of the appropriate lexicalization would be a generation task.

6.4 Operator Scope

Although rare, there are cases in which the choice of the appropriate translation correspondence depends on whether the predicate to be translated is under the scope of an operator or not. In (92) we show the influence of the scopal adverb *wieder* ('again') on the translation of *hier* ('here').

[46] 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.

(92a) Am Dienstag werde ich wieder *hier* sein.
I will be *back* again on Tuesday.

(92b) Am Dienstag werde ich *hier* sein.
I will be *here* on Tuesday.

The adverb *hier* is translated into *back* (92a) if it occurs as predicative under the scope of *wieder*. This is shown in (93a).[47] Otherwise *hier* is mapped onto its standard correspondence *here* by the rule in (93b).

(93a)
```
[L:hier(E)],[F:wieder(P,H),O:support(I,L),L=<H,
 unifiable(E,human,S1)] <-> [L:back(E)].
```

(93b)
```
[L:hier(E)],[O:support(I,L)] <-> [L:here(E)].
```

6.5 Aktionsart

In some cases, the aktionsart of a predication is relevant for disambiguation, such as in (94) and (95), in order to determine the appropriate TL correspondence of the verbs *ausmachen* and *vereinbaren*.

In Verb*mobil*, we distinguish between accomplishments, achievements, activities and states ([Vendler, 1957] and [Dowty, 1979]). The examples in (94) and (95) show that it is not sufficient to access aktionsart information of the verbal predicate only from the lexicon. What we need is a component which calculates the aktionsart of the whole utterance.

(94) Gestern haben wir um 3 Uhr einen Termin *ausgemacht/vereinbart*.
Yesterday at 3 o'clock we *agreed on/fixed/settled* a date.

(95) Gestern haben wir drei Stunden lang einen Termin *ausgemacht/vereinbart*.
*Yesterday we *agreed on/fixed/settled* a date for three hours.
Yesterday we *discussed* a date for three hours.

The German verbs *ausmachen* and *vereinbaren* can be modified by punctual temporal expressions as well as by time span expressions. In the first case (94), the aktionsart of the whole utterance is an accomplishment, and the verb has to be translated into an English verb with the same aktionsart, like *to agree on, to fix* or *to settle*. Assuming that *ausmachen* and *vereinbaren* are intrinsically accomplishments, in (95) a reinterpretation takes place. If modified by a time span expression, the predication becomes an activity (`aktionsart(E,act)`). Because this kind of reinterpretation is not possible with the verbs *to agree on, to*

[47] I.e. the label `H` of `hier` is less or equal the hole `H` introduced by the scopal adverb.

fix and *to settle*, it is neccessary to choose a different translation, e.g. the verb *to discuss* which intrinsic aktionsart is compatible with time span modifiers. The rules in (97) and (98) that refer to the type declarations in (96) take these facts into account.

(96)
```
type(de,abstr_ausmachen,[ausmachen,vereinbaren,abmachen]).
type(en,abstr_discuss,[discuss,sort_out]).
type(en,abstr_fix,[agree_on,fix,settle]).
```

(97)
```
[H:abstr_ausmachen(E)],[aktionsart(E,act)] <-> [H:abstr_discuss(E)].
```

(98)
```
[H:abstr_ausmachen(E)] <-> [H:abstr_fix(E)].
```
[48]

6.6 Mood

The sentence mood is, interalia, decisive for the translation of a small group of German attitude adverbs that undergo head switching, such as *lieber, eher* or *zufällig*. Let us regard the case of *lieber* in (99).

(99a) Kommen sie *lieber* am Montag!
You'd *better* come on Monday!

(99b) Kommen sie *lieber* am Montag?
Do you *prefer* to come on Monday?

(99c) Ich komme *lieber* am Montag.
I *prefer* to come on Monday.

In case *lieber* modifies a verb, such as *kommen* in (99), its translation differs w.r.t. the sentence mood. In imperative sentences, identified by the predicate `sent_mood(imp)`, it is translated into *better* (100a), while in non-imperative sentences it has to be transformed into the attitude verb *prefer* by the head switching rule in (100b) (see section 5.1). Note that the sentences in (99a) and (99b) differ only w.r.t. the sentence mood which can be identified only by prosodic information.

(100a)
```
[H:lieb(I)],[H:comp(I,I2,I3),J:rel(verb,I),sent_mood(imp)]
<-> [H:good(I)].
```

[48] Since the context-free rule in (98) is the default rule for these verbs, aktionsart information has not to be regarded.

(100b)
```
[F:lieb(I),F:comp(I,_,_),del_group_elem(F,G,R),ta_mood(I,X),
ta_tense(I,Y)],[J:rel(verb,I),J:arg1(I,B),not(sent_mood(imp))]
<-> [F:prefer(E),F:arg1(E,B),F:arg3(E,H),ta_mood(E,X),
ta_tense(E,Y),sem_group(G1,R),sem_group(G,[F]),leq(G1,H)].
```

6.7 Number

Next we want to present a case where number information is essential for disambiguation. When modifying a noun, the translation of the adjectival modifiers *ganz* and *gesamt* depends on the number of the noun they refer to, see (101).

(101a) Die *ganzen* Adressen sind verschwunden.
All addresses are lost.

(101b) Ich habe die *ganze* Adresse aufgeschrieben.
I have written down the *whole* address.

The adjective *ganz* has to be converted into the quantifier *all* in case the number of the modified noun is plural (102a).[49] Moreover, the definite article is deleted because in the case of all quantification the reference is unambiguous so that redundancy can be avoided. (102b) shows the mapping to the adjective *whole* which is carried out if the modified noun occurs in the singular.

(102a)
```
[H:ganz_sadx(E),K:def(E,G),del_group_elem(H,G,R)],
[S:rel(noun,E),num(E,pl)] <-> [K:all(E,G,_),sem_group(G,R)].
```

(102b)
```
[H:ganz_sadx(E)],[G:rel(noun,E),num(E,sg)] <-> [H:whole(E)].
```

6.8 Discourse Information

In some cases, extra-linguistic knowledge is required to resolve translational ambiguities. In this section, we give examples for the use of dialog act and dialog history information.

6.8.1 Dialog Act Information

In section 4.1.3, we have shown the use of dialog act information with the disambiguation of the preposition *bei* in the context of attitude expressions. The translation of the verb *wiederholen* causes similar problems.

[49] The predicate `del_group_elem(H,G,R)` takes the label `H` of *ganz* out of its group and `sem_group(G,R)` returns the remaining group members.

(103a) Könnten Sie das bitte *wiederholen*, ich hab's eben nicht verstanden.
Could you *repeat* that, please, I didn't get it.

(103b) Ja, gut, dann *wiederhole* ich jetzt nochmal.
All right, I *recapulate*.

Regard the examples (103a) and (103b). The verbs *repeat* and *recapitulate* are both possible translations of *wiederholen*. *Recapitulate* is normally used to give a summary of a discussion or a part of it. *Repeat* means to do something again.

For being able to disambiguate *wiederholen*, we utilize its place of occurrence in the dialog. While *recapitulate* is usually uttered at the end of a successive appointment scheduling circle, *repeat* can be used at every point in the talk. This information can be extracted from the dialog act. The dialog act *accept* says that "A topic of negation is being accepted." ([Jekat et al., 1995], p. 12). This is exactly the situation which calls for a summary. Hence, the rule that maps *wiederholen* to *recapitulate* (104a) includes a test on the preceding dialog act which has to be an acceptance (`preceding_da(accept)`).[50] (104b) represents the default translation for *wiederholen*, because its use is less restricted.

(104a) `[H:wiederholen(E)],[preceding_da(accept)] <-> [H:recapitulate(E)].`

(104b) `[H:wiederholen(E)] <-> [H:repeat(E)].`

6.8.2 Temporal Perspective Points

In this section, we explore the translation of the adverbs *nächst* ('next'), *kommend* ('next') and *folgend* ('following' or 'after') when they are used to refer to a time in the future. In German, there seems to be a clear preference to use *nächst* and *kommend* to point to a time coming directly after the speech time (105a) and (105b), and to make use of *folgend* for reference to a time that follows a future reference time (105c).

(105a) ...vielleicht noch die Woche oder *nächste* Woche?
...perhaps during this or the *next* week?

(105b) Wann würd's Ihnen denn passen? Ginge es *kommenden* Mittwoch?
When would it suit you? Would it suit you *next* Wednesday?

(105c) Vielleicht können wir gleich in der *folgenden* Woche das zweite Treffen machen.
Maybe we could hold the second meeting right in the week *after*.

[50] If we would refer to the current dialog act, we would need something with the illocution of a confirmation.

However, the Verb*mobil* dialogs do not exibit a consistent usage of the German temporal-deictic adverbs. As shown in (106a) - (106c), *nächst* and *kommend* are also used to indicate a time following a temporal reference point in the future, and *folgend* - to refer to a time coming immediately after the speech time. This causes a translation problem. Depending on the speaker's temporal perspective point, the German adverbs have to be mapped onto other than their regular English equivalents, i.e. *nächst* and *kommend* might be translated into *following* and *after*, and *folgend* might correspond to *next*.

(106a) Das wär' also der erste Termin, Samstag, siebter Mai. In der *nächsten* Woche ist ja ein Feiertag am Donnerstag.
So, the first date is Saturday, May seventh. Thursday the *following* week is a public holiday.

(106b) In der Woche vom zehnten an bin ich unterwegs und in der *kommenden* Woche kann ich erst ab Mittwoch.
In the week from the tenth on I am away, and in the *following* week I'm free only from Wednesday on.

(106c) Heute haben wir Montag, den vierten, und ich würde vorschlagen, entweder gleich die *folgenden* fünf Tage oder ab Mittwoch, dem dreizehnten
Today is Monday the fourth and I would suggest the *next* five days or from Wednesday the thirteenth on.

In English, the use of the corresponding adverbs is more restricted than in German. For reference to a time immediately following the speech time, only *next* can be used, while *following* and *after* are used if a time is addressed from a future reference point. I.e. what we need for the transfer mapping is the information about the speaker's current temporal perspective when uttering *nächst*, *kommend* or *folgend*. This can be identified by consulting the dialog history. In the very beginning of a meeting scheduling circle, the speaker starts from the current time and refers with these adverbs to a day, week, month, etc. that immediately follows it. By every new proposal in the same circle, the speaker might either assume the current or a future reference point. This depends on the length of time interval focused by these adverbs. After having uttered: Wie wär's am *nächsten* Freitag? ('How about *next* Friday?'), in case of a negative response, the speaker may propose next: Und wie sieht's *nächste* Woche aus? ('How about *next* week?'). Here the temporal perspective point for the longer time interval week remains the same. By proposing next a time interval of the same kind or a shorter one as before, the speaker's temporal perspective point changes to the last introduced time, which lies w.r.t. the speech time in the future.

Since the identification of the speaker's temporal perspective requires to keep track of the dialog history, it is determined in the semantic evaluation component. It is requested by `temp_perspect(I,Now/Fut)` in the particular transfer rule (107). Since the behavior of these adverbs can be generalized, we make use of the types declared in (108).

(107a)
```
[H:temp_deictic_adv(I)],[unifiable(I,time,S),temp_perspect(I,now)]
<-> [H:next(I)].
```

(107b)
```
[H:temp_deictic_adv(I)],[unifiable(I,time,S),temp_perspect(I,fut)]
<-> [H:abstr_follwing(I)].
```

(108)
```
type(de,temp_deictic_adv,[naechst,kommend,folgend]).
type(en,abstr_following,[after,following]).
```

7 Summary

In this paper, we have presented a semantic transfer approach by giving an overview over the treatment of various translation problems and the resolution of translational ambiguities.

We have shown that the use of underspecified representations as well as the employment of abstract predicates minimizes the amount of transfer specifications and allows for alternative translations.

Future research, on the one hand, concerns the question of how the idea of abstraction can be optimized. The preprocessing facilities of the monolingual component can be extended to transfer the semantic 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. We also assume abstractions on the lexico-conceptual level, such as a common representation of graduals and their graduated properties.

On the other hand, there is a lot of work to be done on employing reductionist transfer methods. In order to simulate a human interpreter and to make the translation sound more natural, the uttered input has to be cut down to the relevant information.

Finally, the disambiguation methods have to be extended. This concerns the identification of contextual restriction as well as resolution techniques. This is particularly relevant for the disambiguation of nominal predicates, where the involvement of statistical information seems to be promising.

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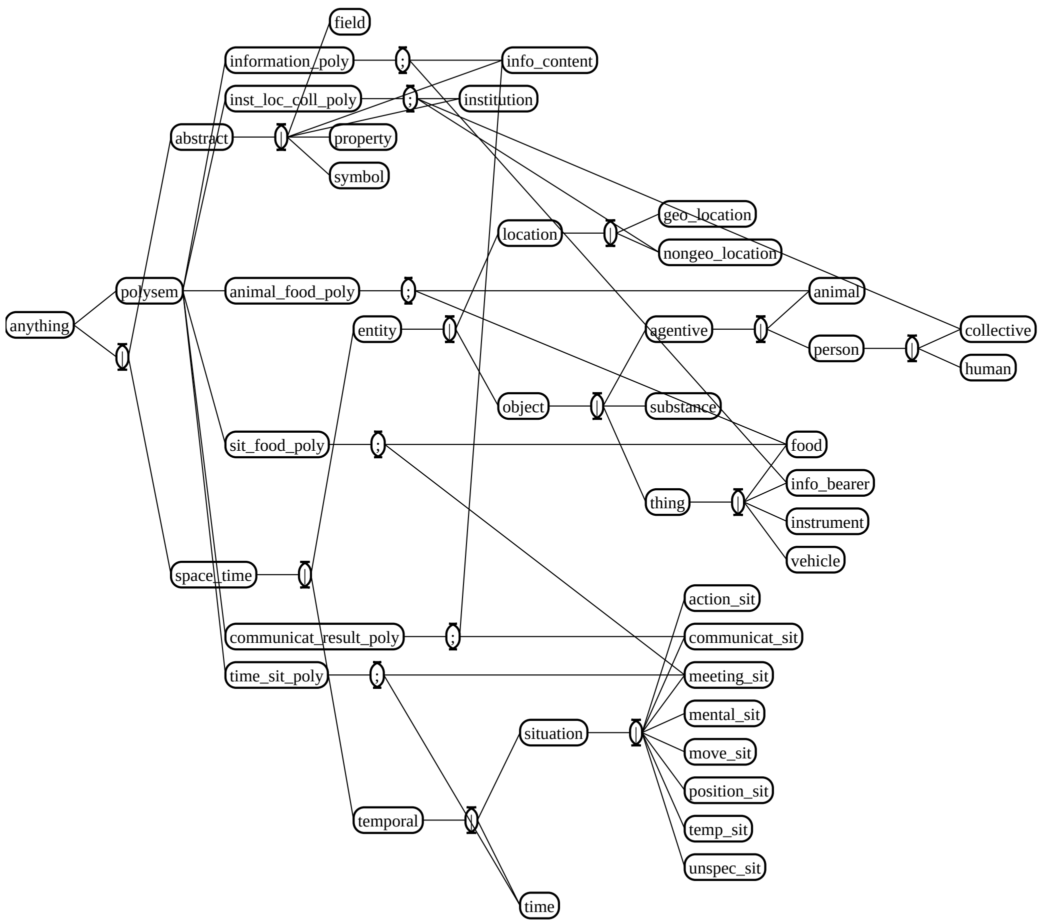

Figure 4: The CUF sort hierarchy