Transfer I: Tense and Aspect

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Contents

1 Introduction

In the machine translation Project Verbmobil the University of Tübingen has undertaken the semantic evaluation and translation of tense and aspectual phenomena (project areas 11 and 12).

For the first phase of the project the domain of investigation consists of spoken dialogs whose object is the scheduling of appointments. As most of the utterances are formulated in the present tense, and as the nature of the dialogs encourages the use of temporal adverbials, we have concentrated primarily on the German present tense, and its interaction with temporal adverbials for the first phase (the Demonstrator). We have also investigated the interaction of quantification, negation, and Aktionsart with tense, and have implemented a basic strategy for dealing with the relevant phenomena in the dialogs.

The treatment of tense and aspect presented here has most in common with the approach taken within Eurotra (Allegranza et al. 1991) in the sense that an interlingua representation based on Reichenbachian temporal relations (Reichenbach 1947) is constructed. That is, we consider it to be given that the semantics of tense and aspect can be formulated within the same semantic representations for all languages, but that identical semantic representations may be realized by differing morphological and syntactic devices in natural language.

Within Verbmobil, syntactic analyses and representations are modeled in the framework provided by Head-Driven Phrase Structure Grammar (HPSG) (Pollard and Sag 1994), while the semantics are based on Discourse Representation Theory (DRT) (Kamp and Reyle 1993). The two theories have been integrated within Verbmobil by instantiating the *sem*(antics) feature of an HPSG sign through a lambda-DRS (see Bos et al. 1994). The semantics of an expression is constructed by traversing the syntactic sign and building up corresponding lambda-DRSes. As part of the semantic construction a tense condition is instantiated within the DRS. The tense morphology of the verbs provides the crucial clues towards constructing the relevant Reichenbachian temporal relations between E (event time), R (reference time) and S (speech time). Furthermore, the presence of temporal adverbials, negation, and quantification is registered and represented within the tense condition.

The evaluation and simultaneous disambiguation of the information collected in the tense condition results in the instantiation of a *sur(face)_tense* feature within the tense condition. This is undertaken as the last step of the semantically-based recursive transfer (VM12 Stuttgart 1994).

The temporal semantics is built up compositionally during the construction of the overall semantics of the expression. It is generally recognized that tense cannot be translated in isolation, but must be sensitive to other information, such as that carried by temporal adverbials in the expression. Differing strategies may be pursued in compositional construction of temporal information.

In the approach taken within the Rosetta system (Apello 1986), for example, translation is achieved through *attuning* the grammars of two languages to one another. Taking a semantic derivation tree (which corresponds to the syntactic D-structure tree) as a starting point, rules are formulated which rely on Aktionsarten information, a perfective/imperfective/retrospective, and a past/present/future contrast. These rules derive a complete tree based on information specified initially for the clause and additional information coming from adverbials. Two trees are considered to be translational equivalents when the history of their derivation is equivalent.

Here the overt syntactic realization of tense and aspect is built into the rules for temporal expressions, which help to derive a particular tree. For example, given the same kind of information with regard to the perfectivity of an expression, an English rule will introduce an auxiliary, while a Dutch rule will not. However, since the derivational step is considered to be one and the same (equivalent rules are triggered), the expressions are translational equivalents.

Within the Verbmobil approach to tense, a compact invariant representation for temporal relations is provided. This representation is independent of the particular syntactic realizations in the source or target languages. Additionally, the surface tense feature contains the result of the "transfer" of tense, i.e., the evaluation of the temporal and aspectual information in light of the English tense system.

This surface tense feature provides a clue to the generation component. In priniciple, however, the generation component is not restricted to the information provided in the surface tense feature, but can also work with the interlingua representation contained in the tense condition. Thus, the generation component is given an interesting degree of freedom: for example, if another verb were chosen as being subtly more appropriate within the given context than one produced by the transfer component, and if that verb changed the Aktionsart of the expression, then the generation component would still have access to the interlingua representation, and be able to generate a more appropriate surface tense.

There are several other distinct advantages that the approach to tense and aspect taken within Verbmobil has to offer. One distinct advantage is that it allows for the ambiguity of certain tenses. The German present tense, for example, can be used to denote both present and future eventualities (Bach 1986).[1] Disambiguation may occur through the presence of temporal adverbials like *morgen* ('tomorrow'), or through context, or not at all. Given that the general approach to disambiguation in Verbmobil is that it should only occur when needed for translation, the possibility of allowing an ambiguous encoding of particular tense morpheme provides a desirable degree of flexibility.

[1]It can also be used for the *historical present*, which is ignored for the purposes of this report.

The treatment presented here is based on an already existing, coherent and internally consistent framework, namely DRT, in which the phenomena under investigation have been thoroughly explored and modeled from a linguistic point of view. For an analysis of the German tense system, we base ourselves primarily on the work by Ehrich (1992). The analysis of the English temporal system is based mainly on Kamp and Reyle (1993). The fact that a solid linguistic base for tense and aspect can be assumed allows an immediate treatment of the better known phenomena, and leaves more room for an investigation and innovative treatment of phenomena that have not been discussed as intensely in the literature, but do occur in the Verbmobil dialogs.

Finally, the implementation presented here is completely monotonic, and yet exceeds the original goals as formulated in our grant proposal by far. For the Demonstrator, we had planned to provide only the prototypical implementation of a tense module. Instead, an approach which provides a broad coverage of the phenomena encountered in the dialogs was implemented.

In what follows, the general approach to the representation and subsequent translation of tense is presented, then the various tenses and the interaction of tense with temporal adverbials, quantification, negation and Aktionsarten is discussed in some detail. Throughout, we also present the problems which we intend to work on intensely for second phase of the project, the Prototype.

2 Basic Approach

2.1 Temporal Relations

Ehrich (1992) presents the attractively simple, and yet sufficiently powerful schema in (1) as the basis for an analysis of the German tense system. The distinction she makes between *contextually* and *intrinsically* determined relations is also sometimes viewed as the difference between tense (relation between R and S) and aspect (relation between E and R) (e.g., Apello 1986, Allegranza et al. 1991).

(1)

		Contextually Determined	
		S, R	R < S
Intrinsic	E, R	Present	Past
Relations	E < R	Perfect	Past Perfect
	E > R	—	—

The notation "S,R" signifies that these times stand in some sort of relation to one another, though whether this relation is one of overlap or temporal precedence is underspecified and is further determined by the context (temporal

adverbials or discourse context).[2]

Within Verbmobil, morphological and syntactic temporal information are mapped to interlingua representations according to the correlations presented in Table (2). For all verbs an E, R, and S is introduced. For infinitives and participles the relation between these times is initially underspecified: the information contributed by the auxiliaries serves to specify the relations in a monotonic fashion.[3] For the simple tenses, the past tense is unambiguously represented as denoting an event which occurs before the speech time. The present tense, on the other hand, is initially realized with an ambiguous specification: either the speech time coincides with the reference time, in which case a "true" present is realized; or the reference time is after the speech time, in which case a futurate interpretation is called for.

(2)

Present Tense Verbs	$E \bigcirc R$,	$R > S$ or $S \subseteq R$
Past Tense Verbs	$E \bigcirc R$	$R < S$
Infinitives/Participles	E,R	R,S
Future Auxiliary		$R > S$
Present Perfect Auxiliary	$E < R$	$R \bigcirc S$
Past Perfect Auxiliary	$E < R$	$R < S$

2.2 Tense within the Semantic Formalism

Concretely, the above information is integrated into the Semantic Formalism in form of a tense condition. The tense condition is a complex condition within the *conds* slot of a DRS. The reader is referred to Figure 1 in Section 2.4 for a complete semantic representation of a simple sentence, in which the tense condition is included. The internal structure of the tense condition is given here.

```
tense_condition   ::    e_rel_r              : tense_rel,
                       r_rel_s              : tense_rel,
                       tense_inst           : marker,
                       e_time               : marker,
                       r_time               : marker,
                       s_time               : marker,
                       tloc                 : tloc_type,
                       sur_tense            : etense_val.
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[2]The future tense is not included in Table (1) as Ehrich follows Vater (1975) in treating the German future auxiliary *werden* as a modal.

[3]Note that no provision is made for future perfects. This will be discussed later on.

The types e_time, r_time, and s_time and the encoding of the relations between them is as described above. The s_time is coindexed with a (contextual) time anchor, whose value is "now". The e_time is coindexed with the instantiation of the verb. Both are thus bound by existential closure.[4]

As it is as yet not possible to evaluate anaphoric relations, or to evaluate temporal adverbials with respect to a calendar model, it is not possible to instantiate an evaluation procedure which would take an temporal adverbial, place it in relation to the speech time, and determine the reference time for the event. The temporal relations as they stand are thus not *inferred* from calendar and contextual information, but are specified lexically. A hierarchical modeling of the set of temporal relations, which are based on the proposals in Allen (1983), further ensures that the various lexical specifications can be combined compositionally and yet monotonically.

In the *tloc* slot information about the presence and particular nature of temporal adverbials is gathered. For example, when *im April* is processed, a value of *st_dist* (distributed around the speech time) is introduced. This is then evaluated as a part of the determination of surface tense, and is simultaneously used to disambiguate the German present. The *tloc* thus in effect situates the event, and would seem to play exactly the role of the reference time (r_time). However, the temporal adverbial which introduces the *tloc* specifications is not explicitly identified with the r_time. This is because they are not always identical. In the case of quantification, for example, there may be a temporal adverb (and, hence, a *tloc*), but when it is contained within the scope of the quantiifier, it may not serve as the r_time for the expression. Furthermore, when there is no explicit temporal adverb in an expression, a reference time which situates the event must still be assumed. This is represented by the r_time, underspecified though it may be.

The issue of reference times in general and their role with regard to temporal anaphora (Partee 1973) in particular will be taken up again in a later section. However, it should be emphasized at this stage that despite the lack of a resolution/inference component in the Demonstrator, quite an impressive amount of the phenomena Verbmobil is confronted with are dealt with successfully.

The feature *tense_inst* serves to identify the tense condition uniquely. In most cases, the value of the tense_inst is exactly that of the e_time, but under quantification and negation the tense_inst is flagged with sortal information in order to be able to identify the tense condition as having been introduced by negation or quantification. The details of the treatment and implementation of quantification with regard to tense are described in the section on quantification.

[4]The label e_time applies to both states and dynamic events – no crucial distinctions are lost with regard to this simplification of terminology since the precise nature of the eventuality is encoded both in terms of sortal information, and in terms of Aktionsarten.

Finally, the *sur_tense* is instantiated as a last step of transfer and contains the English surface tense that the expression should be generated with.

2.3 Aktionsart

One very fundamental component of tense/aspect analyses that has so far not been mentioned is the Aktionsart of a predicate (Vendler 1967). Unlike tense and the information contributed by temporal adverbials, the Aktionsart of a predicate cannot be seen as a condition on a DRS, but must rather be realized as a *perspective* on the entire situation. As such, Aktionsarten information is encoded in a *persp* feature outside of the DRS. The modeling of Aktionsarten information and the compositional "calculation" Aktionsart has been undertaken by IBM-Heidelberg, as described in Egg and Herweg (1994) and Egg (1994a). Unfortunately, the *persp* feature has not been implemented fully for the Demonstrator. As such, the following discussion reflects the scenario as it is visualized with respect to the *persp* feature, not its current realization.

Semantic Evaluation, under which the evaluation of tense and aspect falls, was originally envisioned as "triggered" by the Transfer component only when disambiguation became necessary for translation. This strategy was proposed in order to avoid the costly drawing of inferences necessary for many of the phenomena within Semantic Evaluation. However, the case of tense and aspect is slightly different. In the approach presented here, no inferences need to be drawn. Furthermore, since each and every sentence containing a predicate will contain temporal and aspectual information, and since the intention at Tübingen was to provide a surface tense for all of the expressions handled by the Demonstrator, it seemed that the evaluation of temporal and aspectual information could not be treated as being triggered optionally.

Both the information in the tense condition and the *persp* feature must be arrived at compositionally, so the collection and instantiation of the relevant information most logically should take place parallel to the Semantic Construction. The evaluation of the temporal and Aktionsart information needed for the realization of the English surface tense, however, should clearly be situated within the Transfer component. As the Semantic Construction, Semantic Evaluation (in the form of the BACK/FLEX system (Quantz et al. (1994))), and the Transfer components have in practice all been integrated into a single module, the Minidemosystem (MDS), this division of labor in terms of tense and aspect is in fact supported by the underlying architecture.

The above scenario for the treatment of tense and aspect was agreed upon by the Tense/Aspect partners and representatives from the Semantic Construction in various meetings.[5] In order to keep the amount of management required from

[5]The groups working on diverse tense and aspect phenomena are IBM-Heidelberg, IMS-Stuttgart and Universität Tübingen.