

Aspects of a Functional Grammar for Machine Translation¹

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Abstract

This paper discusses aspects of a functional grammar for Machine Translation (MT). We present a restricted approach to some central issues of "diathesis/ alternations" of predicate-argument structures on a level of "Interface Structure" (IS) for multi-lingual machine translation. The approach generalizes a set of morpho-syntactic phenomena into a set of "diathesis" features with specified interactions with other features at IS. The aim of conforming with the overriding goal of simple transfer is discussed. We suggest extensions to the restricted approach to make it more compatible with ongoing work in knowledge-based MT and in text generation.

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I am grateful to my EUROTRA colleagues Nuria Bel, Mounira Loughraieb, Lee Humphreys, Ursula Reuther, Sibylle Rieder, Anne Becker, and Randy Sharp for critical support in various ways. Recently, I have also profited through critical feedback by John Bateman, Bob Kasper, Leo Wanner, Elke Teich and Elisabeth Maier. I am alone responsible for any remaining weaknesses.

1 Purpose and scope of this paper

The main goal of this paper is the treatment of several closely interrelated phenomena at the level of an Interface Structure (IS) for multi-lingual machine translation (MT) in particular, but hopefully for interface components in other areas of natural language processing as well. The phenomena in question are those of "diathesis" in interaction with voice, arbitrary reference of constituents, certain types of pronominal constructions, and a certain class of morphological reflexives. The partial integration of these particular phenomena as having to do with diathesis and "alternations" of predicate-argument structures is of particular importance for an IS within transfer-based multi-lingual MT, an IS which must be sufficiently general to ensure simple transfer, yet sufficiently structure oriented to recover all the semantically relevant functional information encoded in language specific syntax and morphology. The notion of "transfer" which we are assuming here is based on a single level of transfer (Eurotra Interface Structure), which is mono-lingually related to more syntactic levels of representation. This type of approach of MT is in contrast with, on the one hand, interlingual approaches [Carbonell & Tomita 1987] , and with transfer-based approaches relying on several levels of transfer [Kaplan *et al.* 1989] on the other.

The approach described in section 2 below was initially developed by the author as legislation for "argument structure: grammatical issues" for Eurotra, a multi-lingual MT project of the European Community [Allegranza *et al.* 1990]. As such, it is part of the Eurotra Reference Manual. Version 6.1. December. 1989, i.e. it is embedded in the overall body of Eurotra Linguistic Specifications. Because we are dealing here with the issues under consideration on a largely conceptual, rather than implementational level, consideration of formalisms will be downgraded at this point. The approach in section 2 has been implemented within the official Eurotra formalism [Bech & Nygaard 1988], as well as within the CAT-2 formalism [Sharp 1988]. Implementation within a knowledge-based MT environment is described in [Bateman.J. *et al.* 1989a]. The text generation project KOMET (GMD/IPSI, Darmstadt) carries out the implementation of the extended approach of section 4 [Steiner *et al.* 1990]. The linguistic background to most of what we suggest here is Systemic Functional Grammar [Halliday 1985,Fawcett 1981,Kasper 1988].

2 Eurotra legislation on some grammatical issues of argument structure

The treatment of grammatical issues presented here presupposes a compatible treatment of the corresponding lexical issues [Humphreys 1989]. We shall, in the context of this paper, assume only a very general notion of the argument structure of verbs, i.e. its subcategorization, presupposing that the arguments of a verb are clearly separated from its modifiers, and are identifiable either through indexation, or through a labelling with Semantic Relations. Initially, we shall not make any strong assumptions about an

obliqueness hierarchy among arguments.

Various strands of work within the project work together to motivate the further developments for IS grammars introduced here: multi-linguality and the necessity of simple transfer, the growing need for more clearly defined notions of "a predicate" and "a reading", and the simple necessity to handle constructions of the types exemplified in (1) to (8) (Appendix II) in a theoretically and methodologically sound way.

Below, we shall first summarize our extensions to more conventional IS grammars: We introduce the feature "dia" for diathesis on the sentence node in IS representations with

attribute = dia

values = {activ, passiv, impers, decaus}.

The value-names are short forms for "activization, passivization, impersonal, and de_causativization" respectively. This is essentially an extension of the traditional feature of "Voice/ Genus Verbi". The basic though over-generalizing assumption is that diathesis operations can operate on any (verbal) predicate-argument structure. That is, we regard them as a grammatical counterpart to lexical rules in the sense of [Pollard *et al.* 1987]. In general, processes of diathesis seem to be of four types:

- Changes in argument-grammatical function assignment without change in number
- Reduction of the number of grammatical functions only
- Parallel reduction
- Insertion of a higher order predicate

Diathesis operates in different ways on different predicate-types. The most conservative position would at least require four predicate types like "transitive, ergative, causative, one_role". We shall confine ourselves to this set here, but refer to a larger set in [Steiner 1986, Steiner 1989, Steiner forthcoming].

We introduce a feature "arb_ref = yes" on nodes representing constituents with arbitrary reference. A classical example is the syntactically uninterpreted agent of passive constructions. However, constituents with arbitrary reference may or may not be empty, so that we need the additional feature "argtype=full,empty" on constituents.

We assume a syntactic level prior to IS, representing syntactic relations or functions: "Eurotra Relational Structure" (ERS). The table in Appendix I illustrates combinations of Roles, Argtypes, Arbitrary Reference, Syntactic Function and Diathesis values at IS. In Appendix II, we list a range of constructions, providing examples of IS representations.

3 Remarks on transfer

How does the present approach behave in transfer? It is an improvement over a situation in which we require that we maintain constant

- the geometry of trees at IS, and
- the features for VOICE (active/passive), and
- the argtype-feature.

This previous approach led to complex transfer in cases of translation of Romance "Pronominal Constructions" into Germanic passives (6,7), in cases of Germanic impersonal passives into Romance languages (4,5), in cases of certain "pro-drop" constructions with arbitrary reference of the Subject (2), in cases of Germanic "reflexives" realizing ergative verbs, and in cases involving arbitrary reference plus the argtype=full vs. argtype=empty distinction (1,2,3). (see Appendix II for the examples referred to). By going beyond the mere morpho-syntactic active/passive dichotomy, now using a more functional and therefore less language specific set of categories, we can keep diathesis features constant in the desired cases. While we thus believe to have achieved an improvement over previous legislation in this area, we cannot claim to have achieved a comprehensive treatment of the entire area of alternations/diathesis. Considerably more seems to be involved, especially with respect to the behaviour of "focus" and "theme" phenomena, i.e. we have only dealt with informationally unmarked cases so far. We have sketched an approach to an extended IS elsewhere [Steiner & Winter 1988,Steiner *et al.* 1990,Steiner forthcoming], and shall turn to some recent extensions below.

4 Extensions towards a more functional approach

The use of the approach just outlined within "knowledge-based MT" has already been explored outside Eurotra [Bateman.J. *et al.* 1989a,Schuetz 1989] . This was still done using relatively different grammar modules for German and English which were linked essentially through a level of abstraction beyond grammars, the "Upper Model" [Bateman 1989]. There is now ongoing work to develop bi-directional grammars for German and English, largely based on Systemic Functional Grammar, which contain as one core component an extension of the approach described in sections 2 and 3. We shall concentrate here on the linguistic side of this extension.

Linguistically, a grammar within a more functional approach will cover the classical SFG functional components "experiential, logical, interpersonal, textual". More specifically, it will cover "Transitivity (predicate-argument structures), Time, Diathesis, Subjectivity (several different types of "raising and control" phenomena), Aktionsart, Theme, Focus" and several other areas. Thus we use a grammar which relies heavily on SFG, but is, on the other hand, an extension of it. Examples (9) and (10) show an approach to representing one type of extraposition, or, in Systemic terms, thematization, in functional terms. The phenomenon at issue here is the dissociation of the "Theme" and "New Information" functions on clause level. It is only an approach of this type, we

think, which will successfully handle translations between, say, Romance "Pronominal Constructions" (6,7) and, say, the frequent German thematizing constructions of type (9) and (10).

Another area of development in the functional approach referred to here is an alternative treatment of representations as in (8) below: in this example, and in general for causative constructions of this type, the approach of section 2 still represents the causative predicate as a governor in the tree. Straightforward featurization in an approach which does not allow nested features, such as current Eurotra, seems to enforce this treatment because of difficulties with modification of such governors, cascading, and scoping problems. We shall present a treatment which offers an alternative, based on the assumption of a "Verbal Group" constituent of S, and/or complex features. Causativization, along with other phenomena expressed as control or raising constructions in English are thus back where they belong: they are properties/features of a construction rather than predicates or arguments of it, thus making simple transfer possible, as between (11) and (12) below. Both will be represented as the same predicate argument structure, with the modality operator "featurized". Their functional difference is one of "Theme/Rheme" structure, analogous to (9) and (10), and this is where the difference will be made. Cases like these are discussed more extensively in [Steiner 1989,Bateman 1989,Schuetz 1989].

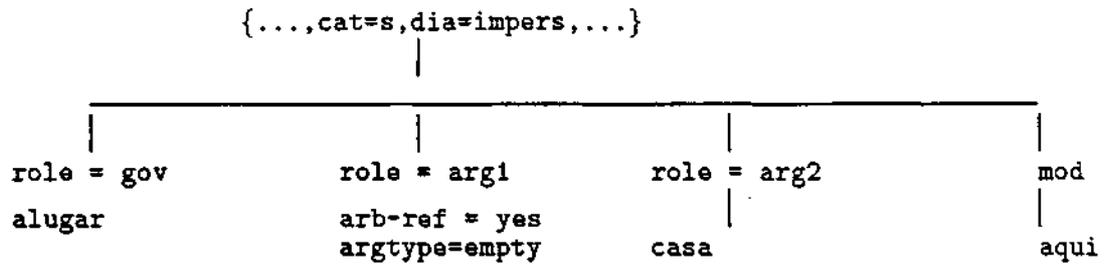
Let us finish with a few closing remarks:

We have commented on the implementational status of our approach here at the end of section 1. We have only touched upon some of the interesting issues of data structures and mathematical models, but the essentials of these aspects are covered in work by [Kasper 1989a,Kasper 1989b]. In this paper, we have concentrated on the linguistic aspects of the functional framework concerned. The talk itself should provide us with the opportunity of discussing some of these questions in more detail.

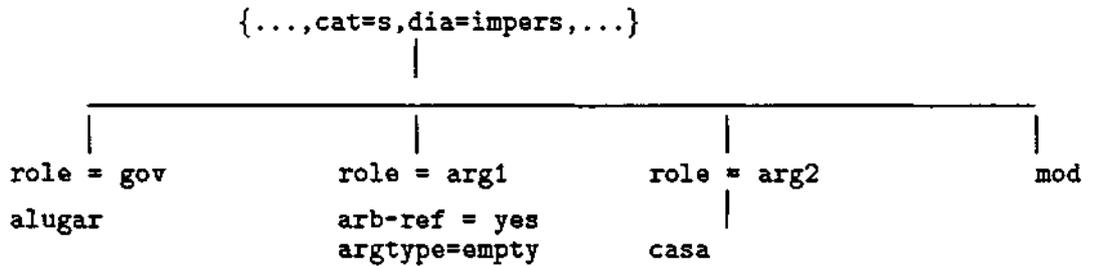
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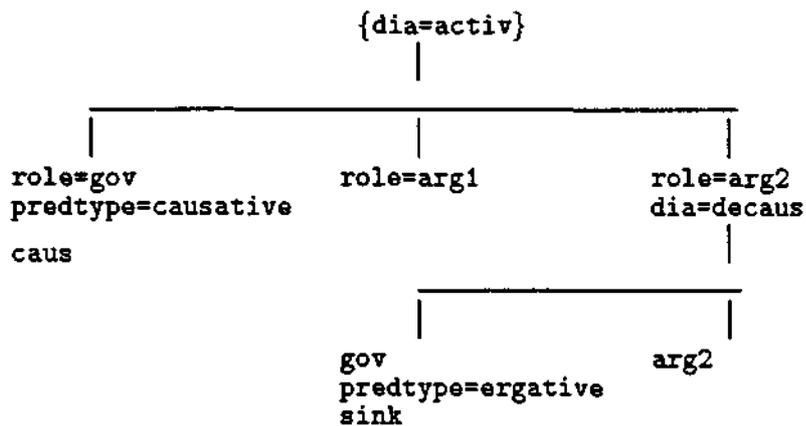
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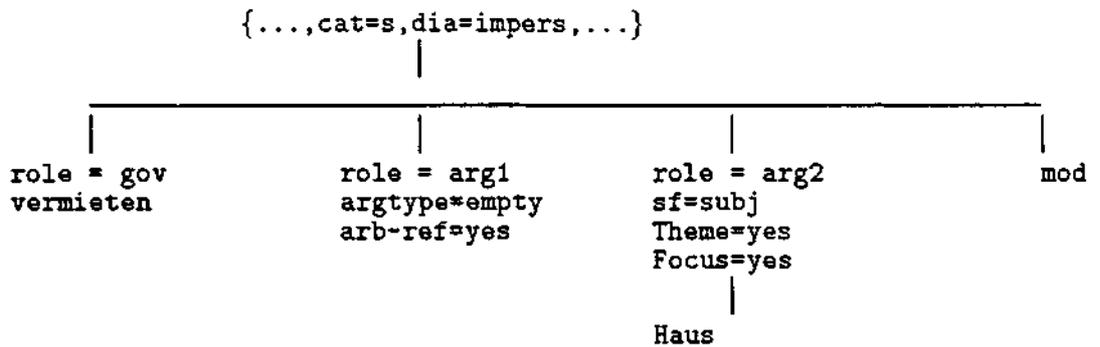
(6) Aluga-se casas aqui.
Se alquila casas aqui.



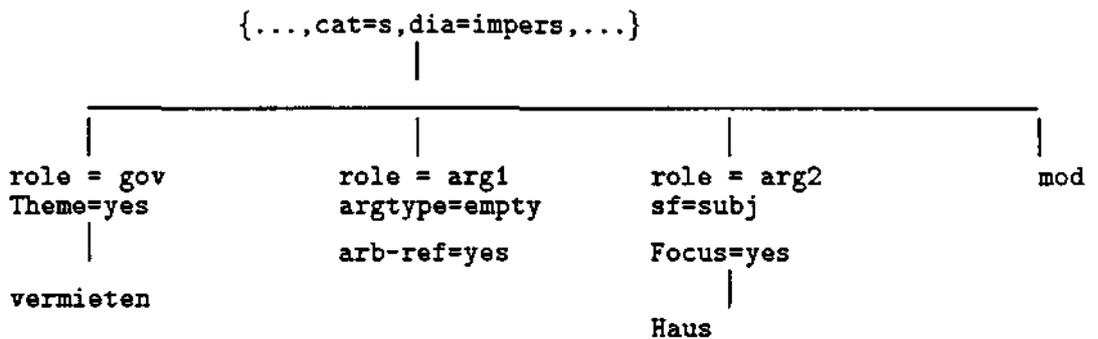
(7) Alugam-se casas aqui.
Se alquilan casas aqui.



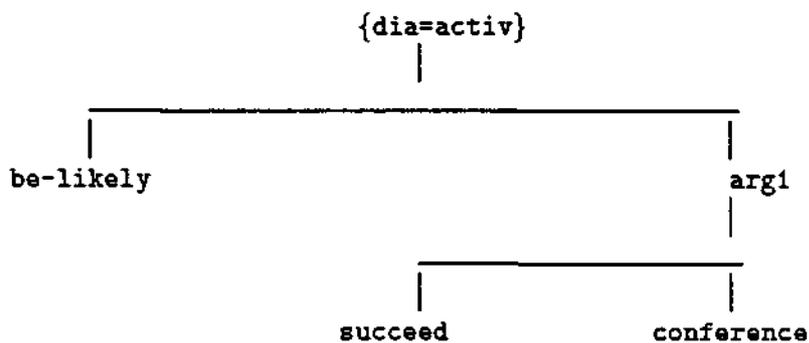
(8) The captain caused the boat to sink.



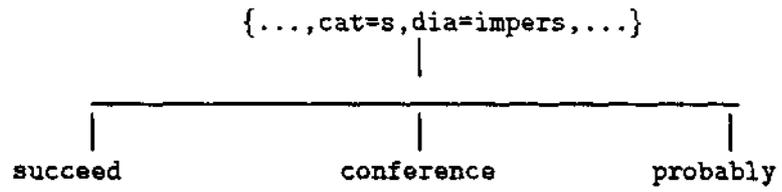
(9) Haeuser werden hier vermietet.



(10) Es werden hier Haeuser vermietet.



(11) The conference is likely to succeed.



(12) Probably, the conference will succeed.