DESIGN OF A MACHINE TRANSLATION SYSTEM FOR A SUBLANGUAGE

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ABSTRACT

This paper describes the design of a prototype machine translation system for a sublanguage of job advertisements. The design is based on the hypothesis that specialized linguistic subsystems may require special computational treatment and that therefore a relatively shallow analysis of the text may be sufficient for automatic translation of the sublanguage. This hypothesis and the desire to minimize computation in the transfer phase has led to the adoption of a flat tree representation of the linguistic data.

1. INTRODUCTION

The most promising results in computational linguistics and specifically in Machine Translation (MT) have been obtained where applications were limited to languages for special purposes and to restricted text types (Kittredge, Lehrberger, 1982). In light of these prospects, the prototype MT system described below[1] should be seen as an experiment in the computational treatment of a particular sublanguage. The project is meant to serve both as a didactic tool and as a vehicle for research in MT. The development of a large-scale operational system is not envisaged at present. The following research objectives have been defined for this project:

- to establish linguistic specifications of the sublanguage as a basis for automatic processing;
- to develop translation algorithms tailored to a computational treatment of the sublanguage.

The emphasis of the research lies in defining the depth of linguistic analysis necessary to adequately treat the complexity of the text type with a view to acceptable machine translation. It is the conjecture of our research group that, within the particular sublanguage defined by our corpus, acceptable translation does not necessarily depend on standard linguistic structural analysis but can be obtained with a relatively shallow analysis. Thus, as a working hypothesis, the principle of 'flat trees' has been adopted for the representation of the linguistic data. Flat trees, as opposed to deep trees, only partially reflect the dependency structure obtained by a traditional IC-analysis. The adoption of flat trees goes hand in hand with the further hypothesis that the sublanguage can be translated mechanically with only minimal semantic analysis similarly to the TAUM-METEO system (Chevalier, et al., 1978).

[1] Project sponsored by the Swiss government.

2. THE SUBLANGUAGE

The corpus is taken from a weekly publication by the Swiss government announcing federal job openings. The wordload of this publication amounts to ca. 10,000 words per week; however, many of the advertisements are carried for several weeks. All job adds are published in the three national languages: German, French and Italian, with German usually serving as the source language (SL), French and Italian as the target language (TL). The study is hence based on a collection of texts already translated by human translators. The ads are grouped according to profession, e.g. academic, technical, administrative, etc. At present, the corpus is limited to the domain of administrative positions, an example of which is given in figure 1.

Verwaltungsbeamtin
Fonctionnaire d'administration
Funzionaria amministrativa

Führen des Sekretariates eines Sektionschefs. Ausfertigen von Korrespondenzen und Berichten nach Diktat und Vorlage in deutscher, französischer und englischer Sprache. Abgeschlossene kaufmännische Lehre oder Handelsschulbildung. Berufserfahrung erwünscht. Sprachen: Deutsch, Französisch, Englisch in Wort und Schrift. Italienisch und/oder Spanisch erwünscht.

Diriger le secrétariat d'un chef de section. Dactylographier de la correspondance allemande, française et anglaise et des rapports sous dictée ou d'après manuscrits. Certificat d'employée de commerce ou diplôme d'une école de commerce. Expérience professionnelle désirée. Langues: le français, l'allemand et l'anglais parlés et écrits. Connaissances de l'italien ou de l'espagnol, voire des deux souhaitées.

Dirigere il segretariato di un capo sezione. Stesura di corrispondenza e rapporti secondo dettato o manoscritto. Tirocinio commerciale o formazione commerciale. Pratica pluriennale. Lingue: tedesco, francese, inglese (orale e scritto). Buone nozioni dell'italiano e/o dello spagnolo auspicate.

Figure 1. Advertisement for an administrative position ("Die Stelle", 1981).

The corpus exhibits many of the textual features generally used to characterize a sublanguage, i.e. (i) limited subject matter, (ii) lexical and syntactic restrictions, and (iii) high frequency of certain constructions. As can be seen from the example, the style of the sublanguage is distinguished by complex nominal dependencies with various levels of coordination. In addition, most sentences are incomplete in that they consist of a series of nominal phrases and do not contain a main verb; no relative phrases nor dependent clauses occur. The importance of nominal constituents is reflected in the statistics of the German texts: over 55% of the words in the corpus are nouns, 11% adjectives, 11% prepositions, 17% conjunctions; verbs only make up 1% of the corpus. A comparison with the statistics of the French and Italian translations reveal approximately the same distribution except for infinitival verbs. The higher frequency of verbs in French and Italian is due to a preference for infinitival phrases in place of deverbal nominal constructions. Apart from this difference, the major textual characteristics carry over from source to target sublanguage thereby facilitating mechanical translation.

3. BRIEF DESCRIPTION OF THE SYSTEM

Modern transfer-based MT systems are based on the following design principles : (i) modularity, e.g. separation of linguistic data and algorithms, (ii) multilinguality i.e. independent analysis, transfer, and generation phases, (iii) formalized specification of the linguistic model (Hutchins, 1982). Although only a prototype, the system was designed in accordance with these considerations.

As to modularity, the software used is a general purpose rule-based transducer especially developed for MT (Shann, Cochard, 1984). This software tool not only allows for the separation of data and algorithms but also provides great flexibility in the organization of grammars and subgrammars, and in the control of the computational processes applied to them.

As a multilingual system it is not directly oriented towards any specific language pair; the same German analysis module serves as input for the German-French as well as the German-Italian transfer module. Separate French and Italian generation modules use only language specific knowledge to produce the final translation. However, the German analysis is indirectly influenced by target language considerations: the interface structure between analysis and transfer was defined to take advantage of the similarities between the three languages and to accommodate the differences.

4. LINGUISTIC APPROACH: MINIMAL BUT SUFFICIENT DEPTH

With the sublanguage investigated displaying restricted syntactic structures within a limited semantic domain, a grammar specifically tailored to these job advertisements can be defined. Moreover, the linear series of nominal phrases as well as the almost one-to-one lexical equivalences found in the SL and TL texts suggest that a shallow analysis without a semantic component is sufficient for adequate translation. The flat tree representation resulting from such a minimal depth approach does not make any claim to linguistic generalizability for purposes other than the translation of this particular sublanguage.

4.1 Computational considerations

In a transfer-based MT system, actual translation takes place in transfer and can be described as the computational manipulation of tree structures. In the absence of any formal theory of translation for MT, and given the relatively well-developed analysis techniques currently available, a major concern in MT research is to minimize the computation necessary in the transfer phase. A flat tree representation provides one way of simplifying the structures to be processed; an interface representation defined to accommodate both SL and TL structures in the same manner, thus avoiding tree structure manipulation, is yet another means. The representation of the linguistic data in this system is a direct result of these two considerations.

4.2 Flat trees

The fact that the linearity of the surface structure constituents carries over from SL to the TLs justifies the adoption of a minimal depth analysis. The analysis is restricted to the identification of the phrasal constituents and their internal structure; dependencies holding between constituents are only partially computed. Thus, the interface structure resulting from analysis and serving as input to transfer does not reflect a linguistically correct dependency structure. Instead, the IS respects the linear surface order of the constituents (with the exception of predicate groups, see below) in a flat tree representation.

In a flat tree, the major phrasal constituents, in particular the prepositional phrases, are not attached at the node from which they depend linguistically but at specified nodes higher up in the tree. Schematically, the differences can be illustrated as follows:

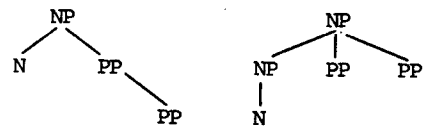
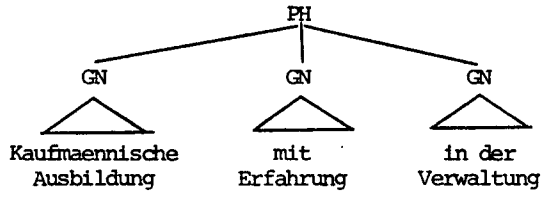


Fig. 2. Standard IC-tree vs. Flat tree

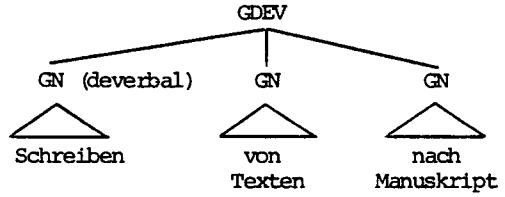
The flat tree representation applies to all three major phrasal constituents defined for this corpus: (i) nominal phrases proper, (ii) deverbal

nominal phrases, and (iii) verbal phrases. Samples taken from the corpus are given below to illustrate each of the three constituent structures.

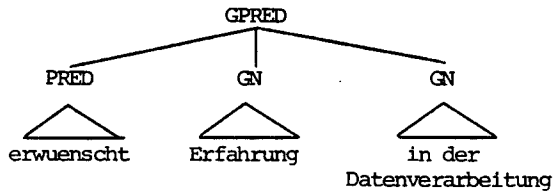
(i) Nominal phrases proper have a standard noun phrase as their head, possibly followed by a linear sequence of prepositional phrases. (GN stands for both standard NPs and PPs.)



(ii) Deverbal nominal phrases have a deverbal noun as their head, followed by a linear sequence of GNs.



(iii) Verbal phrases have a predicate as their head, followed by a linear sequence of GNs. (PRED encompasses predicative participles, predicative adjectives, and infinitival predicates; the few finite verbs in the corpus (0.4%) are not treated.)



("Erfahrung in der Datenverarbeitung erwuenscht")

4.3 Normalized tree structures

In order to further minimize manipulation of structure in transfer, the interface representation is also normalized for two important categories in the sublanguage, namely deverbal nominal phrases (GDEV) and noun and prepositional phrases (GN). The structures are defined such that they remain valid for both the source and target language.

4.3.1 Deverbal nominal phrases

A marked stylistic difference between the SL and the TLs occurring with high frequency in the corpus is the translation of a German deverbal noun into an infinitive in French and Italian. With the deverbal noun in German usually serving as the head of a complex nominal structure with several complements, the translation of the noun into an infinitive in the target language changes the type of complement structure accordingly. The complete linearization of the deverbal complements provides a format for accommodating the target language infinitival construction aimed at in translation. Structural transfer is thus reduced to renaming the nodes; the normalized tree structure remains the same, as can be seen in the SL and TL representations shown below.

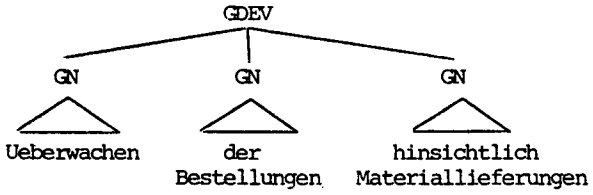


Fig. 3. SL (German) deverbal nominal phrase analysis.

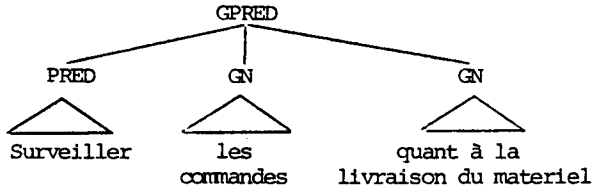


Fig. 4. Equivalent TL (French) verbal phrase analysis.

4.3.2 Noun phrases and prepositional phrases

Certain noun phrases in German (e.g. genetive attributes) are translated into prepositional phrases in French and Italian. In order to avoid structural transfer of noun phrases into prepositional phrases and vice-versa, a normalized form for noun phrases has been defined which reserves a position in the tree for prepositions. For standard noun phrases a special value (NIL) has been defined to fill the empty preposition slot. Therefore, in the transfer phase, a translation from a noun phrase to a prepositional phrase or vice-versa is merely a change in the value of the prepositional slot without any change in the tree structure.

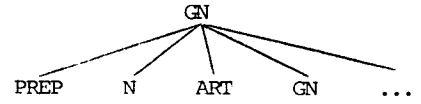


Fig. 5. Example of the normalized form for NPs and PPs.

4.4 CONSIDERATIONS FOR TRANSLATION

The goal of the system, and perhaps of MT in general, has to be to carry over the information content from SL to TL, to produce output acceptable

in terms of TL conventions, and to respect the style of the text type. It seems that treating a well-defined sublanguage enhances the possibilities for an MT system to answer these requirements. In fact, the sublanguage itself suggests possible strategies for dealing with some of the classical translation problems in MT such as (1) lexical ambiguity, (2) translation of prepositions, and (3) treatment of coordination.

4.4.1 Lexical problems

Two well-known lexical problems in computational linguistics are homograph resolution and polysemy disambiguation. Given the small number of possible syntactic structures in the sublanguage, the few homographs found in the corpus do not present any problems for analysis. In turn, the limited semantic domain of the sublanguage completely eliminates multiple word senses so that the transfer of lexical meanings is basically a one-to-one mapping. Therefore, with the nouns serving as the major carriers of the textual meaning, lexical transfer ensures that the information content of the text is carried over.

4.4.2 Translation of prepositions

The fact that the types of nouns occurring in the sublanguage are restricted and repetitive and that the possible prepositions commanded by any given noun is small in number (max. 3 in the corpus) allows the adoption of a limited noun-focused approach for the translation of prepositions. In such an approach, it is the particular noun or noun class rather than general semantic features that determine the translation of prepositions. At present, the information relevant to correct translation of prepositions is attached to individual noun entries in the transfer dictionary; semantic noun subclassification similar to other sublanguage research (Sager, 1982) is being investigated.

4.4.3 Coordination

With SL and TLs exhibiting parallel surface syntactic structure, and with inherent ambiguities of scope therefore carrying over, analysis of coordination remains shallow. Conjunctions and intrasentential punctuation are defined functionally as coordinators to yield, in keeping with the flat tree representation, a structure such as the one shown below.

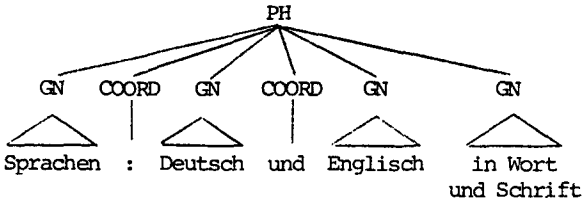


Fig. 6. Coordinated structure at sentence level.

5. CONCLUSION

The evidence available to-date seems to show that, for the particular sublanguage dealt with, correct translation is feasible under the hypotheses described in this paper. The non-generalizability of such an approach is quite evident; however, the fact that such a 'minimal depth' approach seems to work for this particular sublanguage gives substance to the impression that specialized linguistic subsystems differ quite sharply, both in complexity and linguistic features, from the standard language and may therefore require special computational treatment.

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