BEDE: A MICROPROCESSOR-BASED MACHINE TRANSLATION SYSTEM

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The proposed paper describes an on-going research project being carried out by staff and students at the Centre for Computational Linguistics to design a limited-syntax controlled-vocabulary machine translation system of sophisticated design to run on a microprocessor.

1. Background

Bede is essentially a research project: we are not immediately concerned with commercial applications, though such are clearly possible if the research proves fruitful. Work on Bede at this stage though is primarily experimental. The aim at the moment is to investigate the extent to which a microprocessor-based M.T. system of advanced design is possible, and the limitations that have to be imposed in order to achieve a working system. This paper describes the overall system design specification to which we are currently working.

In the basic design of the system we attempt to incorporate as much as possible features of large-scale M.T. systems that have proved to be desirable or effective. Thus, Bede is multilingual by design (i.e. not based on language pairs) (cf. King, 1981:12); algorithms and linguistic data are strictly separated (cf. Johnson, 1979:140); and the system is designed in more or less independent modules (cf. Vauquois, 1965:33).

The microprocessor environment means that criteria of size are important: data structure both dynamic (created by and manipulated during the translation process) and static (dictionaries and linguistic rule packages) are constrained to be as economical in terms of storage space and access procedures as possible. Limitations on in-core and peripheral storage are important considerations in the system design.

In large general purpose M.T. systems, it is necessary to assume that failure to translate given input correctly is generally not due to incorrectly formed input, but to insufficiently elaborated translation algorithms. This is particularly due to two problems: the lexical problem of choice of appropriate translation equivalents, and the strategic problem of effective analysis of the wide range of syntactic patterns found in natural language. The reduction of these problems via the notions of controlled vocabulary and restricted syntax seem particularly appropriate in the microprocessor environment, since the alternative of making a system infinitely extendable is probably not feasible. Both notions have been tried with bigger systems, resulting both in better results from the M.T. system itself, and in increased legibility from a human point of view of source texts (cf. Ducrot, 1972; Elliston, 1978; Lawson, 1979:81-2; Sommers and McNaught, 1980:49).

Given these constraints, it seems feasible to achieve translation via an 'interlingua' (cf. Veillon, 1969; Hutchins, 1978:131), in which the canonical structures from the source language are mapped directly onto those of the target language(s), avoiding any language-pair oriented 'transfer' stage. Translation thus takes place in two phases: analysis of source text and synthesis of target text.

2. Brief description

A description of the system forms the second half of the proposed paper. For the sake of clarity and brevity in

this summary, we refer to the attached schematic representation of the translation process in Bede. In the full version of this paper, each step is to be outlined in rather more detail.

The analyser uses a chart-like structure (cf. Kaplan, 1973) to produce the interface trees of the abstract interlingual representation. These trees serve as input to synthesis, where they are rearranged into valid surface structures for the target language.

The source text is translated sentence by sentence (or equivalent). Text is first subjected to a two-stage morphological analysis. In the first stage the text is compared word by word with a stop-list of frequently occurring words (mostly function words); words not found in the stop-list undergo morphological analysis, again on a word by word basis. Morphological rules form a finite-state grammar of affix-stripping rules ('A rules') and the output is a chart with labelled arcs indicating lexical item and possible interpretation of stripped affixes, as confirmed by dictionary look-up. The morphological analysis phase also creates a temporary 'sentence dictionary' consisting of copies of the dictionary entries for (only) those lexical items found in the current translation unit.

The chart then undergoes a two-stage syntactico-semantic analysis. In the first stage, context-sensitive phrase--structure rules ('E rules') work towards creating a single arc spanning the entire translation unit: arcs are labelled with appropriate syntactic class and syntactico-semantic feature information and a trace of the lower arcs which have been subsumed. In the second stage, the tree structure implied by the labels and traces on these arcs is disjoined from the graph and undergoes general tree-to-tree-transduction rules ('T rules') resulting in a single tree structure representing the canonical form of the translation unit. With source-language lexical items replaced by unique multilingual-dictionary

addresses, this is the interlingua which is passed for synthesis into the target language(s).

Synthesis consists of a combination of T rules which reassign new order and structure to the interlingua, and of context-sensitive rules which can be used to assign mainly syntactic feature labels to leaves ('L rules'), for example for the purpose of assigning number and gender concord (etc.). The resulting list of labelled leaves (the superior branches are no longer needed) is passed to morphological synthesis where a finite-state grammar of morphographemic and affixation rules produces the target string.

As can be seen, the system is strictly modular, and at each interface only a small part of the data structures used by the donating module is required by the receiving module. The 'unwanted' data structures are written to peripheral store to enable recovery of partial structures in the case of failure or mistranslation, though automatic back-tracking to previous modules by the system as such is not envisaged as a major component.

The 'static' data used by the system consist of the different sets of linguistic rule packages, plus the dictionary. The system essentially has one large multilingual dictionary from which numerous software packages generate various subdictionaries as required either in the translation process itself, or for lexicographers working on the system. Alphabetical or other structured language-specific listings can be produced, while of course dictionary updating and editing packages are also provided.

3. Implementation details

The system will run on any microprocessor system which runs under the CP/M operating system and at C.C.L. is implemented on the Intertec Superbrain with twin $5\frac{1}{4}$" double density floppy disk drives, giving a total of 320k bytes of on-line

store. Programs are written in Pascal/M (Sorcim, 1979), a Pascal dialect closely resembling UCSD Pascal.

4. References

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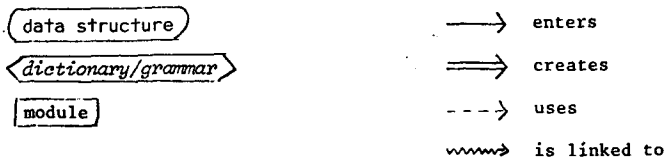
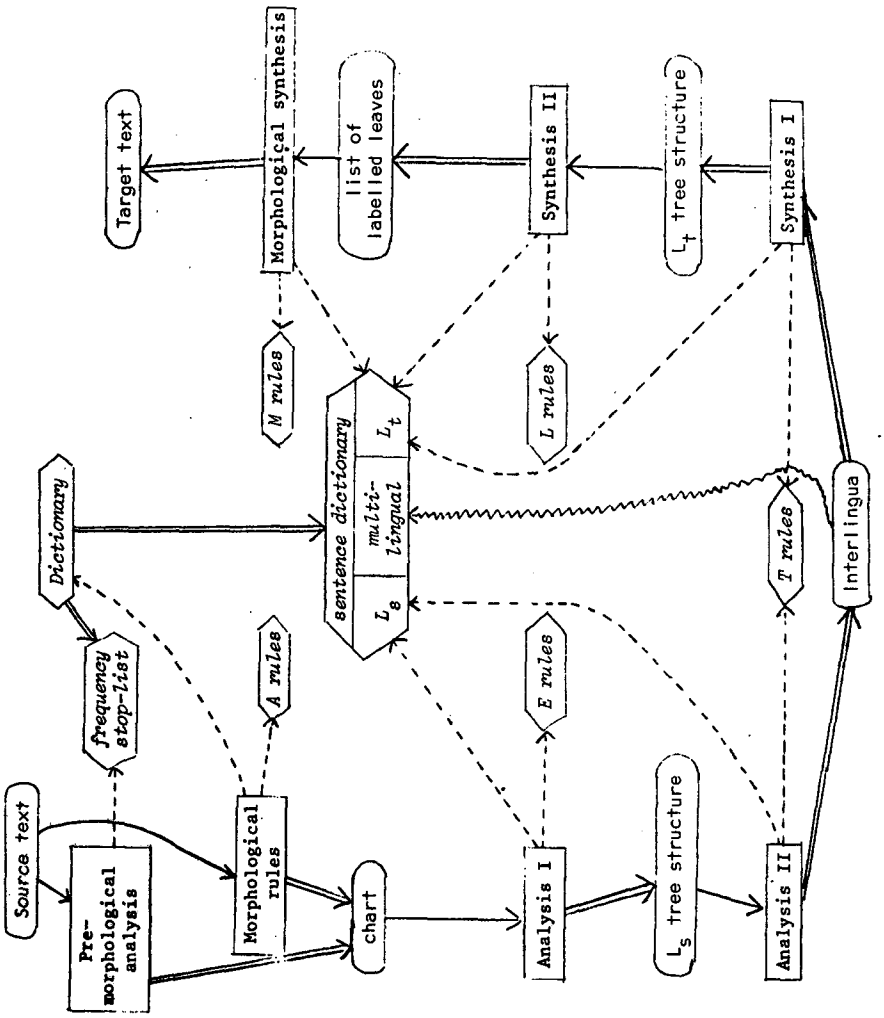
Key to the scheme (see overleaf):





Schematic representation of the translation process in Bede