Machine Translation: A Knowledge-Based Approach

Sergei Nirenburg, Jaime Carbonell, Masaru Tomita, and Kenneth Goodman
(Carnegie Mellon University)

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The KBMT Project: A Case Study in Knowledge-Based Machine Translation

Kenneth Goodman and Sergei Nirenburg (editors)
(Carnegie Mellon University)

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Machine translation (MT) research in the United States has enjoyed a bit of a revival in the last several years. Building on research in semantic analysis from both natural language processing and computational linguistics, many recent MT efforts have taken a "knowledge-based" approach, in which an attempt is made to analyze text meaning, and use this analysis to improve on the translation.

Two books have recently been written by various members of Carnegie Mellon University's Center for Machine Translation (CMT). In *Machine Translation: A Knowledge-Based Approach*, the authors, Sergei Nirenburg, Jaime Carbonell, Masaru Tomita, and Kenneth Goodman, claim to survey major recent developments in knowledge-based machine translation (KBMT). Although there are some references to other KBMT systems, I found the book to be less of a survey and more of a description of CMT's efforts in KBMT, plus some more general discussions about the merits of the knowledge-based approach as compared to other approaches. As such, it is a worthwhile book. CMT has been one of the key sites in the revival of MT research in the U.S., and several of their projects are surveyed in some detail. In addition, some key difficulties in building knowledge-based systems, such as lexicon construction, are addressed.

The book begins with a discussion of some of the controversial issues in MT and the stands on these issues taken in the KBMT approach. The most important is the issue of transfer versus interlingua. In a nutshell, the question is: can analyzers and generators for the various languages in an MT system share the same (interlingual) representation, or must representations vary, with *transfer* modules being responsible for converting from the source language representation to the target language representation? I think the authors are correct in concluding that this controversy really boils down to the question of how much semantic analysis is performed in an MT system. The more semantic analysis, the more like an interlingua the representation is likely to be. Aside from this point, though, I did not find the discussion to be particu-

larly original; many of the same points have been raised countless times before, dating as far back as Bar-Hillel's 1960 article discussing the feasibility of fully automated MT.

The next several chapters discuss the various components of several of CMT's KBMT systems. Chapter 3 discusses a more-or-less standard frame system, called Ontos, in which domain knowledge is represented. This chapter also discusses how to represent the other types of information, such as speaker goals, the speech situation, and other pragmatic factors that might affect translation, although there is no discussion in the book about how to extract this additional information from the source language text.

CMT's feature-based lexicon structure is discussed in Chapter 4, along with some discussion on how lexicons might be constructed in a semi-automated fashion. Here, the efforts of other groups are discussed more fully, including the efforts by Wilks and colleagues (1990) to use machine-readable dictionaries to acquire information for the lexicon, and sophisticated interfaces that allow for more rapid manual development of knowledge bases.

Chapters 5 and 6 discuss parsing and generation. The parsing strategy is an adaptation of Tomita's (1986) algorithm to a unification-style grammar. The generation discussion focuses on issues such as text planning and lexical selection. Chapters 7 and 8 are somewhat peripheral to the rest of the book, discussing speech-to-speech translation and applying some KBMT techniques to machine-aided translation.

Finally, the book concludes by discussing the future of KBMT. The authors predict that several trends will develop: a trend toward more interactive systems, in which the interface between system and human translator is more seamless; and a trend toward "situated MT," in which MT capabilities are incorporated into other types of systems, such as information retrieval systems.

The second book, *The KBMT Project: A case study in knowledge-based machine translation*, edited by Kenneth Goodman and Sergei Nirenburg, is billed as a companion to the first book, devoted to describing in more detail the KBMT-89 project, an IBM-sponsored system for English–Japanese and Japanese–English translation. I found the two books to be redundant, the latter describing in more detail many of the features of KBMT-89 that were discussed more briefly in the former. Rather than viewing these as companion books, the reader should choose one or the other, depending on the emphasis that he or she would prefer. Whereas the first book discusses some broader issues in addition to providing some of the details of CMT's systems, *The KBMT Project* is devoted almost exclusively to the details of KBMT-89, with little discussion of more general issues.

Analysis and generation are the two areas that are most fully discussed in the second book. Chapters 3–5 contain detailed descriptions of the unification-based grammar used in KBMT-89, issues in constructing a grammar, and the structure of the lexicon. Chapter 7 discusses the same Tomita-style parsing algorithm that is discussed in the first book. The generation lexicon is described in detail in Chapter 6, and the generation algorithm is presented in Chapter 9.

A third module, called the *augmenter*, is discussed in Chapter 8. This module functions as "a bridge between parsing and generation." While this may sound like CMT's answer to a transfer module, it really can be viewed as part of the analysis phase. The augmenter is responsible for tasks such as ambiguity resolution and transforming the semantic representation into one that is less reliant on the surface structure of the source text. The augmenter also contains a module that enables a user to augment the representation manually, thereby allowing human intervention to improve the translation. This feature is rather unique, in that rather than enabling pre- or post-editing, the human translator can assist the system during an intermediate step.

While CMT's efforts are clearly a huge step forward over the MT systems of the 1950s and 1960s, whose inferior performance led to the demise of MT research in the U.S. for about twenty years, unfortunately there is little attempt in these books to evaluate the research presented. It is to be hoped that attempts to objectively evaluate the performance of these systems will be forthcoming. Nirenburg et al. quote Slocum (1985): "What matters ... are two things: whether the systems can produce output of sufficient quality for the intended use ... and whether the operation as a whole is cost-effective." These criteria will undoubtedly constitute the ultimate evaluation of the KBMT approach.

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