A COMPUTATIONAL MODEL OF TENSE SELECTION AND ITS EXPERIMENTATION WITHIN AN INTELLIGENT TUTOR

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ABSTRACT. The paper presents a new computational model for the selection of verb tenses aimed at supporting the choice and conjugation of the appropriate tense in English sentences. The work has been developed within the framework of the ET research project whose purpose is the experimentation of intelligent tutoring systems for foreign language teaching. The model has been validated and experimentally tested through the development of TEN-EX (TENse EXpert), a prototype system which receives in input a representation of an English sentence and is capable of finding and conjugating the appropriate tense(s) for it. The model originates from the functional-systemic approach to tense from which it inherits the basic ideas of tense opposition and seriality. The model is characterized by some original assumptions such as the partitioning of the tense selection process in two separate phases aimed at discovering the 'objective' tense, relating speaking time to event time, and at mapping the objective tense into the actual grammatical tense. This bipartite organization corresponds to the idea that the tense selection process is influenced by both the temporal semantics of the situation a speaker intends to describe and the pragmatic and syntactic features which act as a filter in mapping the objective tense into the grammatical resources of the language at hand. TEN-EX is a fully implemented system which is currently capable of solving more than 80 exercises covering all the English indicative tenses.

1. Introduction

The study of the verb tense has traditionally arisen the interest of linguists and philosophers concerned with the semantics of natural language. Linguists have tried to describe the properties (at the morphological, syntactical or semantic level) of the tense in the different languages, while the philosophers have attempted to characterize its usage conditions. More recently, however, the issue of tense has attracted the attention of people interested in the construction of systems capable of automatic natural language processing since the tense of the verb plays a major role in the possibility of describing - and in understanding the description of - complex events. (For some recent collection of papers on this topic see: Dahl 1985; Dowty, 1986; Tedeschi and Zaenen 1981; Webber, 1988).

Our interest for the issue of tense has a different source since it originates from the efforts to construct intelligent tutoring systems for foreign languages. In the last few years we have built different versions of ET, a prototype tutor capable of supporting the learning of the English tense system (Fum, Giangrandi, and Tasso 1988, 1990; Fum, Pani and Tasso 1991, in press). As it is known, a fundamental component of a tutoring system is represented by the so called domain-expert module which incorporates the knowledge constituting the system expertise that has to be transmitted to the student. In the domain of tutoring systems for foreign languages, this module is supposed to incorporate the knowledge underlying the competence of a native speaker, in our case the system of rules supporting the use of English tenses.

In the paper we present a new computational model for the selection of tense which has been validated and experimentally tested through the development of TEN-EX, a prototype system capable of solving the tense generation problem. More particularly, the system, after receiving in input a schematic representation of an English sentence, finds and conjugates the appropriate tense(s) for it. The model originates from the functional-systemic approach to tense from which it inherits the basic ideas of tense opposition and seriality. The model is characterized by some original assumptions such as the partitioning of the tense selection process in two separate phases aimed at discovering the 'objective' tense relating speaking time...
to event time, and at mapping the objective tense into the actual grammatical tense, respectively. This bipartite organization corresponds to the idea that the tense selection process is influenced by both the temporal semantics of the situation a speaker intends to describe and the pragmatic and syntactic features which act as a filter in mapping the objective tense into the grammatical resources of the language at hand.

The paper is organized as follows: The next section illustrates the systemic approach to tense developed theoretically by Halliday (1976) and, from a computational point of view, by Matthiessen (1983, 1984). In the section some criticisms to the Matthiessen's approach are raised which motivate the development of our original model. Section 3 is devoted to the presentation of the new model from the theoretic point of view, to the discussion of its basic assumptions, and to the description of the knowledge it relies upon. Section 4 deals with the implementational aspects of TEN-EX in which the theoretical model has been realized, and provides an example of interaction with the system giving an idea of its capabilities. Section 5 ends the paper by making a general evaluation of the model and by suggesting some guidelines for future research.

2. The Systemic Theory of Tense

In this section the systemic approach to the problem of tense selection is briefly described. What follows is based on the work of Halliday (1976) and, in particular, of Matthiessen (1983, 1984).

According to the systemic approach, two assumptions are made concerning the grammar of the English tense. These assumptions are:

a) Tense opposition: the tense in English is considered as a three term opposition of past vs. present vs. future.

b) Seriality: complex tense combinations can be constructed by repeatedly selecting among the three term opposition.

The two assumptions reduce the process of tense selection to a series of iterative choices within the three terms option. In other words, a tense combination like 'is going to have built' is chosen by picking up the first time (primary tense) the present, then (secondary tense) the future and finally (ternary tense) the past. The name for a tense combination in the systemic approach is determined by considering the inverted order of the choices: in our case the tense combination is a past-in-future-in-present.

Halliday identifies a series of 'stop rules' which capture the restrictions that the English grammar puts on the usage of tense and state which possible tense combinations are admissible. An important consequence of the rules is the fact that up to quinary tenses (like: 'will have been going to have been taking': a present-in-past-in-future-in-past-in-past) are allowed by the grammar. The rules define whether a tense combination is legitimate but they do not indicate how a given tense combination is selected. To this end, a significant contribution has been given by Matthiessen with his notion of chooser. To each option concerning the tense, Matthiessen assigns a procedure (or chooser) that states how the selection among the options specified is controlled.

According to this point of view, a verb tense essentially indicates the temporal relationship which holds between the so called speaking time Ts (i.e., the moment in which a sentence is uttered) and the event time Te (i.e., the moment in which the action or event described in the sentence is supposed to happen), and the tense selection process is based on such a relation. More particularly, for each iteration step, the choosers take into account a relation of precedence (anteriority) - that we symbolize through '<' - between two different temporal variables called the reference time (Tr) and the comparison time (Tc), respectively. If:

- Tr comes after Tc (Tc < Tr), then the past is chosen;
- Tr comes before Tc (Tr < Tc), then the future is chosen;
- otherwise the chosen tense is the present.

The process starts by setting the time variable Tr to the speaking time Ts and by looking for the comparison time Tc, i.e., the time interval the speaking time is related to. At this point it is possible to choose the primary tense according to the relation which holds between the values