

# TEACHING THE ENGLISH TENSE: INTEGRATING NAIVE AND FORMAL GRAMMARS IN AN INTELLIGENT TUTOR FOR FOREIGN LANGUAGE TEACHING

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## ABSTRACT

A basic problem that must be dealt with in order to build an intelligent tutoring system (ITS) in the domain of foreign language teaching is that of establishing what kind of grammatical knowledge has to be included in the domain expert module. Two basic options are possible: (i) to use a naive or pedagogical grammar, comprising knowledge derived from textbooks and school grammars or (ii) to use one of the formal grammars developed by theoretical and computational linguists. The paper discusses the relationships between naive and formal grammars in foreign language teaching and presents, as a case study, an attempt to integrate the two approaches within ET (English Tutor), an ITS aimed at helping Italian students master English verb usage. More particularly, the paper focuses on the possibility of integrating a naive grammar into a systemic framework. The reliability of the proposed approach is currently being evaluated by means of a series of computational experiments with the Verb Generation Expert of ET.

## INTRODUCTION

A problem that must be dealt with in order to build an ITS in the domain of foreign language teaching is that of establishing what kind of grammatical knowledge has to be included in the Domain Expert module. At first sight, two distinct options are possible:

- a) to utilize the knowledge contained in textbooks and school grammars;
- b) to adopt one of the formal grammars developed by theoretical and computational linguists.

Both these solutions have their shortcomings.

Traditional grammar textbooks have serious drawbacks which concern both their content and the way it is presented to the student. The introduction of the notional syllabuses and the almost general adoption of the communicative approach have somehow changed the general attitude and the strategies utilized in foreign language teaching, but even the grammars that follow these methodologies do not overcome the most severe limitation of what we call the *naive* approach to the representation of linguistic knowledge, i.e., the incapacity to provide a global and coherent model of language.

The formal grammars developed by linguists, on the other hand, show their shortcomings when we try to use them directly for didactic purposes. The point is that these grammars have been developed to pursue goals that are different from those of school grammars. Theoretical linguists are in fact interested in providing mathematically well defined descriptions of a language which capture the competence of a native speaker. Computational linguists are interested in discovering computationally effective models of the processes that allow the speaker to utter or to understand a sentence in that language. Considered from the point of view of a foreign language teacher, these formal descriptions are generally useless since the (meta)language in which they are framed and the concepts which they are grounded upon are different from those utilized in daily teaching.

The relationship between formal and naive grammars in foreign language teaching is dealt with in this paper which presents, as a case study, an attempt to integrate the two approaches within an intelligent tutoring system. The work has been carried on in the framework of the ET (*English Tutor*) project whose long term goal is the development of a tutoring system aimed at helping Italian students master English verb tenses. Within this project, ET-1, a prototype system based on a naive approach to the grammar of tense (described in Fum, Giangrandi, and Tasso, 1989), has been built. The experimentation performed with ET-1 provided the motivation for a critical re-evaluation and revision of some of the assumptions which the prototype was grounded upon. The possibility of formulating some naive intuitions into a systemic representation of grammatical knowledge is discussed in the paper and a new version of the domain expert module exploiting the systemic approach to tense selection is illustrated. The following section presents our previous naive approach to a grammar of English verb tense, describes how the grammatical knowledge has been utilized by the domain expert module of ET-1, and clarifies why such an approach has been found in the long run unsatisfactory. The next section illustrates the systemic approach to tense developed by M.A.K. Halliday (1976) and C. Matthiessen (1983, 1984). Our original contribution is then presented and it is shown how the naive approach has been integrated into a systemic framework. The

last section presents some evaluation criteria for the present proposal.

## A NAIVE APPROACH TO TENSE SELECTION

The basic goal pursued in constructing the domain expert module - called Verb Generation Expert - of ET-1 has been that of building a glass-box model of the competence underlying the choice and conjugation of an English verb tense. One of the main concerns in designing the knowledge base for this module has been that of maintaining the wealth of ideas and intuitions existing in the naive account of tenses while developing at the same time a computationally tractable model of the tense selection process.

In order to build the Verb Generation Expert module, we started by examining the explanations about tense usage given in a set of reference grammars and by extracting a set of *tense features* representing the ideas and concepts which were utilized in providing such explanations. Then we described according to these features the set of exercises to be presented to the students.

To give a more concrete idea of what the descriptions looked like, we report here the (simplified and partial) representation of an exercise:

*Yesterday, when I (arrive), Tom (talk) on the telephone.*

(defexercise ex5

(text (Yesterday when I (arrive) Tom (talk) on the telephone))

(structure ex5 (clauses (c1, c2)))

(defclause c1

(text (when I (arrive)))

(in-exercise ex5)

(open-item (arrive))

(clause-kind (subordinate temporal))

(superordinate (c2))

(clause-form affirmative)

(open-item-time-interval t1)

(fact-kind (action single))

(aspect (action completed))

...

(deftemporalrelations ex5

(before t2 now)

(during t1 t2)

(during t1 t3)

(during t3 t2)))

Each exercise is usually constituted by one or two clauses in which some of the verbs are given in the infinitive form and have to be conjugated into the appropriate tense. The exercise is described through lists of attribute-values pairs, one for each clause.

The first member of the pair indicates a tense feature, the second member the value the feature receives in the clause. The exercise description comprises also a list of *temporal relations* expressing the relationships that exist between the time intervals mentioned in the sentence. These time intervals are associated with the situations (states and/or events) described by the sentence verbs and with the temporal expressions occurring in the sentence, and are represented through the symbols *t1 .. tn*. In our exercise, for example, we find two verbs and one temporal expression, therefore three time intervals are utilized to describe the exercise. The time interval *t1* is associated with the state indicated by the verb *to arrive*, the time interval *t2* with the temporal expression *yesterday*, and so on. The temporal relations specify the relationships existing between these intervals so, for example, (*during t1 t2*) states that the time interval *t1* is included within the interval *t2*: the verb *to arrive* indicates thus an action that happens within the time interval represented by *t2* (i.e., *yesterday*). A special time interval is represented by the symbol *now* which stands for the *speaking time*, i.e., the interval during which the sentence is being uttered.

Since the number of the potential temporal relations holding between the time intervals contained in the sentence could be quite large, only the relations directly derivable from the exercise text are explicitly represented in the description. At the beginning of its operation, the Verb Generation Expert deduces therefore from the stated temporal relation all the possible relations holding between the various time intervals. In doing this, it applies a set of inference rules that implement a reduced version of Allen's temporal logic (Allen, 1984).

In order to be able to choose the tense for a sentence clause containing an open item, it is generally necessary to know not only the relation between the time in which the sentence is uttered and the time of the events described in the sentence, but also the relation which holds between the event time and the so called *reference time*, i.e., the interval of time the situation described in the clause refers to. So, for example, in the sentence:

*By the end of next month I shall have finished my thesis.*

the speaking time is *now*, the event time is given by the time interval associated with the action *to finish the thesis* and the reference time is constituted by the time interval indicated with *by the end of next month*.

In some clauses the reference time may be absent and, in such cases, the only temporal relationship involved in the choice of the tense is that which holds between the speaking time and the event time.

In the following operation step, the Verb Generation Expert computes the reference time (if it exists) for every exercise clause through a series

of production rules. In our case the following rules applies among others:

*IF the clause is a main clause,  
there is a subordinate temporal clause related to it,  
the event time includes the event time of the subordinate temporal,  
THEN set the reference time to the event time of the temporal subordinate clause.*

The rule asserts that the main clause *c2*:

*Yesterday Tom (talk) on the telephone*

has as its reference time *t1*, i.e., the time interval represented by the event time of the subordinate temporal *c1*:

*when I (arrive).*

Once the reference times for the exercise clauses have been computed, it is possible to choose the tense for each open item. To do this, a set of tense selection rules are used. The antecedent of these rules is constituted by some conditions concerning the tense features that must hold in the clause description, while the consequent indicates the tense that has to be assigned to the open item. In our example the following rules are utilized for the clauses *c1* and *c2*, respectively:

*IF the clause describes a past event,  
the reference time is past,  
the event is completed  
THEN use the simple past tense.*

and

*IF the clause describes a past event,  
the reference time, if defined, is past and it is included in the event time,  
the event is not completed  
THEN use the past continuous.*

According to our rules, therefore, the tense that is chosen for *to arrive* is the simple past while *to talk* has to be conjugated into the past continuous.

The last thing that needs to be done at this point is to conjugate the verbs into the chosen tenses. For the regular verbs a set of conjugation rules are exploited, whereas the conjugation of the irregular forms is performed by a simple dictionary look up.

Leaving aside some computational complexities deriving from the need of drawing the logical temporal inferences and of computing the reference time for each exercise clause, the process performed by the Verb Generation Expert relies on the same concepts and rules described in the naive grammars. However, the adoption of the naive

approach has its problems as we realized by experimenting with the prototype.

First of all, the translation of a naive grammar into a computationally suitable form is not straightforward. The explanations given by the naive grammars - the 'tense selection rules' that are derived from the textbooks - are in fact incomplete and even inconsistent. As a result, ET-1 was sometimes incapable of solving a given exercise since the rules of the grammar did not cover that particular case. In other instances we found the opposite to be true, i.e., we obtained multiple incompatible solutions for the same exercise since several rules could be legitimately applied to the case at hand. The computational application of the naive grammars, in other words, disclosed some deficiencies and incongruities that went unnoticed in the original formulation.

Second, the informal concepts used in the naive grammars and utilized in ET-1 to express the tense features have generally no well stated definition. This means that it is difficult to attribute unequivocally the value to the temporal features describing an exercise since a lot is left to the insight of the exercise coder. Different implementers can thus describe the same exercise in a different way and obtain therefore different, often incompatible, solutions.

From the experimentation performed with the prototype, and from an analysis of its limitations, the need of a theoretically sound formulation of the grammatical knowledge, keeping as far as possible the 'cognitive transparency' of the naive grammar, has arisen.

## THE SYSTEMIC APPROACH TO TENSE SELECTION

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. From a linguistic point of view, it is an opposition of past vs. present vs. future; from a semantic point of view, as we will see below, it is interpretable as a precedence relation between two temporal variables.
- b) *Seriality*: complex tense combinations can be constructed by repeatedly selecting among the three term opposition.

As far as the first assumption is concerned, it should be noted that not all the linguists agree with the idea of English as a three-tense language. It is sometimes claimed, in fact, that in English it is possible to distinguish only between present and past, the future being a modal form of the present.

The second assumption reduces the process of tense selection to a series of iterative choices concerning the three term 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*.

An important point concerns which possible tense combinations are allowed. It should be noted that, according to Halliday, up to quinary tenses (like: 'will have been going to have been taking': a present in past in future in past in past) are admissible in English. Some tense combinations, however, are not allowed; in English, for instance, there is no future in future in present and the following sentence is considered ungrammatical:

\* *Henry is going to be going to cook dinner*

The restrictions that the English grammar puts on the possible tense combinations are called 'stop rules' by Halliday and can thus be paraphrased:

1. The present can occur only at the ends of the tense sequence (as a beginning or final choice).
2. Except in the last and penultimate place, the same tense cannot occur in two consecutive positions.
3. The future can occur only once, apart from the last position.

These 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, and represented in the grammar through a system, Matthiessen assigns a chooser "that states how the selection among the options specified is controlled. A chooser is a procedure that consists of steps that ascertain conceptual distinctions and make grammatical choices according to the conceptual distinctions." (Matthiessen, 1984, pg. 1).

According to this point of view, a verb tense essentially indicates the temporal relation which holds between the speaking time and the event time, and the tense selection process is determined by 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 (let us call them  $T_x$  and  $T_y$ ) and:

- if  $T_x$  come after  $T_y$  ( $T_y < T_x$ ), then the past is chosen;
- if  $T_x$  comes before  $T_y$  ( $T_x < T_y$ ), then the future is chosen;
- if none of the above alternatives holds, then the chosen tense is present.

The process, in other words, starts by setting the time variable  $T_x$  to the speaking time  $T_s$  and by looking for the *comparison time*  $T_c$ , i.e., the time interval the speaking time is related to. This

is the time that is assigned as a value to  $T_y$ . At this point it is possible to choose the primary tense according to the relation which holds between  $T_x$  (=  $T_s$ ) and  $T_y$  (=  $T_c$ ). If the comparison time matches the event time  $T_e$ , then the temporal relation holding between  $T_s$  and  $T_e$  has been found and the resulting tense combination consists only of a primary tense (a simple present or a simple past or a simple future). If, on the other hand, the comparison time is different from the event time, the process cannot terminate since no temporal relationship has been established between the speaking time and the event time. A new iteration cycle starts by assigning the old  $T_c$  to  $T_x$  and by looking for a new comparison time  $T_c$  to be assigned to  $T_y$ . The choice of the secondary tense is made again according to the relation holding between  $T_x$  and  $T_y$  and the process terminates if  $T_c$  matches  $T_e$ . If this is not the case, the process goes on according to the same modalities with a tertiary, quaternary or quinary tense, until a link between the speaking time and the event time will be found.

## COMBINING THE NAIVE AND SYSTEMIC APPROACHES

The view of grammar as a set of resources from which to choose, and the focus on the social role of language, are two of the reasons that support systemic grammar as a candidate formalism for didactic utilization. It is evident, in fact, that the notion of choice, the concept on which such grammars are based, is more familiar to teachers and students than other abstract principles (e.g., unification) which other formalisms rely upon. The emphasis on the functional organization of the language - how it presents speakers with systems of meaningful options as a basis for communication - makes systemic grammar in keeping with modern approaches to language teaching. But there are other reasons that support such a choice. Among these we mention:

- the fact that the grammar of tense, the subset of language that concerns us in the ET project, is well documented in the systemic approach through papers by Halliday himself (Halliday, 1976) and, from a computational point of view, by Matthiessen (1983, 1984);
- the interest shown by Halliday for the issues related to teaching, and the fact that much of his writing has been aimed at this topic (see, for example, Halliday, McIntosh and Stevrens, 1964);
- the fact that the systemic approach provides us not only with a static description of linguistic structures but, especially in the computational application of Matthiessen, with a runnable model of language;
- the fact that it is possible to translate the systemic approach into rigorously formal terms (Patten and Richie, 1987) and to express it into

a notation that is compatible with the formalisms, like functional unification grammar, currently used in computational linguistics (Kasper, 1987).

For all these reasons, the systemic approach has been judged particularly suitable to serve as the conceptual ground for an intelligent tutoring system devoted to the foreign language teaching. At the best of our knowledge, this is the first time that a (subset of) a systemic grammar has been utilized as part of an ITS.

The most important problem that has been dealt with in applying the systemic model to the representation of the grammatical knowledge for the new Verb Generation expert has been that of the construction of the tense determination rules (choosers) capable of establishing in a cognitively transparent way (i.e., using as much as possible the ideas and concepts of the naive approach) a tense combination according to the assumptions of seriality and opposition of the systemic approach. Adopting these assumptions led to a complete change of the original verb generation strategy which was based on the direct choice, in a single step without iteration, of the verb tense according to a heterogeneous set of features taken into account by the rule antecedents.

Solving the problem of tense determination according to the systemic approach requires finding the solution to the following subproblems:

- how to choose the tense in each iteration step;
- how to stop the iteration process.

We have examined in a previous section Matthiessen's proposal. His procedure for choosing the tense in each step is based on successive comparisons between the reference and the comparison time, while the termination procedure is based on a match between the current comparison time and the event time.

The burden of the whole process falls primarily on the identification, in each iteration step, of the appropriate comparison time, and this is performed through a dialogue between the choosers and an environment representing the semantic and pragmatic factors influencing the choice of the tense. These factors are, however, hidden from the choosers which simply receive from the environment the answers to their inquiries. In other words, the choosers work by exploiting only the temporal relations between the different times, while the semantic and pragmatic factors play a covert role in the identification of the comparison time the choosers receive as input.

According to our point of view, it is possible to make explicit the criteria underlying the determination of the tense and build cognitively adequate choosers that utilize them directly. In our new approach, this is done by dividing the features used by the tense selection rules of the naive grammar into two classes: the first class comprises those features which express the temporal relation among the time intervals occurring in the exercise sentence; the second class comprises the features of

morphological, syntactic, semantic, and pragmatic information. These two classes play a different role in determining a tense combination. More particularly, the temporal features are utilized by a first type of chooser which discriminates in each iteration step between past vs. present vs. future (*selection choosers*). The remaining features are utilized by a different category of choosers whose task is to establish whether the tense selection process should be iterated or not (*termination choosers*). Differently from Matthiessen, however, the decision of the termination choosers is not based on a simple matching procedure which checks whether a link between the speaking time and the event time has already been established. This decision instead exploits a series of more complex factors through which the criteria underlying the determination of a tense combination in a given language are made explicit.

Let us clarify this new approach, which integrates the systemic treatment of tense with the use of the features found in the naive grammars, by reconsidering, as an example, the exercise presented in a previous section:

*Yesterday, when I (arrive), Tom (talk) on the telephone.*

The solution to this exercise requires the use of the (simple) past for the first verb and the present in past (or past continuous) for the second open item. While in the previous version of the Verb Generation Expert these solutions were chosen through appropriate rules that directly established the correct tenses, according to the systemic theory the tense determination process is iterative. In other words, the first tense is determined by choosing past for the primary tense and halting the process. The second tense is determined by choosing past as the primary tense, iterating the selection process for the secondary tense in which present is chosen, and then stopping.

In order to perform such a process, both the selection and termination choosers are needed. In our case, the following chooser applies:

*IF the clause describes a past event,  
the reference time is past,  
THEN set the primary tense to past.*

This chooser is very similar to the naive tense selection rule utilized to establish that a given verb should be conjugated into the simple past: it has been obtained, in fact, by withdrawing from that rule the condition concerning an aspectual feature (the event is completed). The selection choosers work thus by exploiting only the temporal features, and the choice among past vs. present vs. future is performed by taking into account only the temporal relations among the states and events described in the sentence. This chooser allows the identification of past as the primary tense for both the open items of the exercise. As for the first

open item, after the primary tense has been selected, a termination chooser can be applied:

*IF the primary tense is past  
the clause contains an explicit time  
expression  
the action described in the clause has been  
completed*  
*THEN stop.*

The termination choosers work by exploiting features of morphological, syntactic, semantic, and pragmatic information. While the tense selection choosers take into account the temporal aspects of the tense determination process, the termination choosers represent an interface between the tense system of a particular language and the relationships among the states or events described in a sentence the speaker intends to convey through the usage of a given tense.

In our case, the first condition determines the applicability of the chooser (it represents one of the termination choosers for the (simple) past), while the remaining conditions put forward two of the criteria that establish when the simple past represents a necessary and sufficient tense combination for expressing a given meaning: i.e.. when the action described in the sentence has been completed in the past at a definite time.

No termination choosers are applicable to the second open item which therefore resorts to a secondary tense selection. The following selection chooser applies:

*IF the clause has a definite reference time,  
the event time is equal to or includes the  
reference time*  
*THEN set the secondary tense to present.*

As a result of the action performed by the chooser, the secondary tense is set to the present. After the secondary tense has been determined, the following, very simple, termination chooser applies:

*IF the primary tense is present,  
the secondary tense is past*  
*THEN stop.*

According to the systemic grammar of English tense, in fact, no further tenses are possible after a combination of present in past has been chosen.

## FUTURE DEVELOPMENTS

In the paper a new approach to the problem of determining the tense combination for an English sentence has been proposed with integrates the treatment of tense in a systemic grammar with the naive approach in school grammars. The systemic theory provides general assumptions (i.e. three-tense opposition and seriality) which the tense selection process relies upon, while the naive

features provide the criteria for terminating the selection process. The integration of the naive approach into a systemic framework can be evaluated according to three different perspectives:

- *Computational.* How effective is the proposed theory? What is its coverage? How general is it?
- *Pedagogical.* Is it possible to utilize such a theory to really teach the English verbs? How efficient is such an approach in comparison with the traditional one?
- *Psychological.* To which extent does the serial theory of time mirror the real processes that occur in the mind of a speaker ?

The ongoing research tries to answer these questions. A series of computational experiments with the new Verb Generation Expert, implemented in PROLOG on a MacII, is under way with the goal of establishing the reliability of the proposed approach. The construction of a new Tutor aimed at teaching the serial theory of time is under development. Finally, a series of psychological experiments concerning the cognitive validity of the systemic treatment of tense are being planned.

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