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Exploiting Knowledge Representation in an Intelligent Tutoring System for English Lexical Errors

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Abstract

Intelligent Tutoring Systems (ITSs) construction requires lots of domain knowledge created by hand. In this paper we attempt to illustrate a central role that knowledge representation can play in automating ITS design and implementation. We propose a Diagnosis, Interaction and Treatment (DIT) Model for ITS. The entire system relies upon a knowledge representation system (InfoMap) whose structured encoding of English lexical information makes it possible to (1) initiate the relevant dialogue with learners when the system is not sure about learners' intentions, (2) trigger the appropriate lexical knowledge based on their responses, and (3) automatically generate practice and test exercises based on this knowledge.

Keywords

Intelligent Tutoring System, Knowledge Representation, Error Diagnosis

1: Introduction

This paper aims to design a prototype of an ITS which is based on knowledge representation schemes. For a tutoring system to be intelligent, it must be able to respond correctly to a student's needs. We first focus on lexical errors of writers learning English as a Second Language (ESL).

Most spelling checkers are designed only for detecting errors and giving appropriate suggestions such as Microsoft Word Spelling Checker and Webster on-line dictionary (<http://www-m-w.com>) are good at error checking but lack a pedagogical component. We assume that tutorial is the distinction between tutoring systems and spelling checkers in lexical errors diagnosis.

The error diagnosis process of general ITSs is performed by a verbatim comparison against a pre-determined answer key [2][1]. DIT diagnoses the possible errors by word reduction rules and inflection regulations without knowing the answers beforehand. Moreover, error classification is based on two surveys on the analyses of Chinese students' common errors [4]. Our approach, the core is to understand why students make mistakes.

2: The Framework of DIT

DIT is responsible for the following steps upon learner input: 1. sentences parsing, 2. lexical errors checking, 3. a clarification dialogue is triggered when ambiguity occurs, 4. grammar aids associated with the error type are selected and administered to the student, 5. exercises are automatically generated from the dictionary's structured knowledge. The above steps can be executed in a cycle, depending on the student's exercise results. Suggestions and comments can be retrieved from the knowledge representation platform InfoMap.

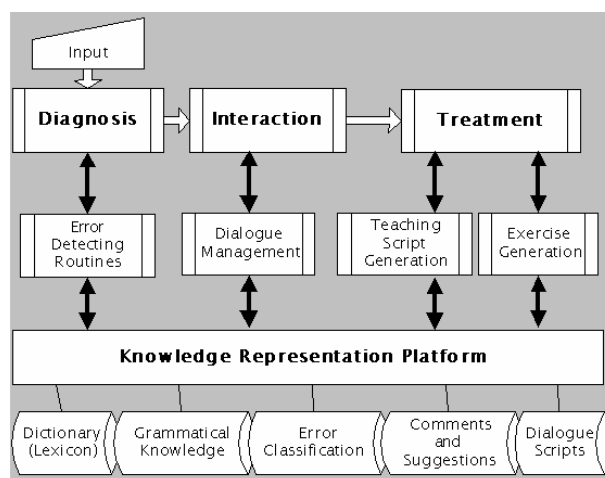


Figure 1. The framework of DIT

3: Knowledge representation on InfoMap

3.1: InfoMap Basics

InfoMap [3] can be regarded as an ontology with tree-like structure as shown in figure 2. Generally, nodes in InfoMap fall into two categories: concept nodes and function nodes. Concept nodes represent entities, attributes, states, and events; function nodes show how the concepts are interconnected. The basic function nodes are: Category, Attribute, Instance, Synonym, Script, Condition, and Activity. Usually, a root is the name of a domain such as English Tutoring or Elementary School Mathematics Tutoring. Subclass relations organize categories into a

taxonomy or taxonomic hierarchy. For example, “morphological errors” is a subclass of “lexical errors”. Furthermore, many knowledge sources (such as WORDNET and the Longman Dictionary) can be embedded into InfoMap.

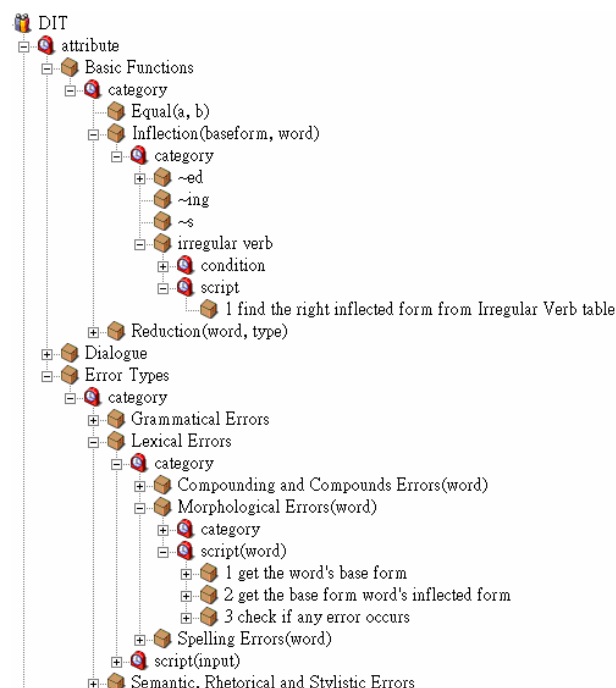


Figure 2. An illustration of knowledge representation on InfoMap

3.2: Using InfoMap to Support the DIT Model

The DIT model for lexical errors provides an open writing environment. We allow students to write freely without an exercise model at the beginning.

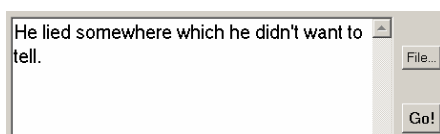


Figure 3. Sentence Input window

The input window has no length limitation. Diagnosis algorithms for identifying specific error types and accessing the relevant information are stored as scripts within InfoMap under a special function node “script” (see figure 2). Without grammatical and contextual information, it is difficult to resolve the ambiguity of what the student intends to write. As can be seen in figure 3, there is a problem of choosing the appropriate meanings of “lie” in the given sentence. InfoMap provides several kinds of dialogues to serve different purposes. Figure 4 shows that “lie” has two meanings when its part of speech is irregular verb and regular verb. In this case, DIT initiates a dialogue “Which one do you want to use?” The information demonstrated on the dialogue window is extracted from our dictionary. Semantic Dialogue will guide the student to choose what he intended to write.

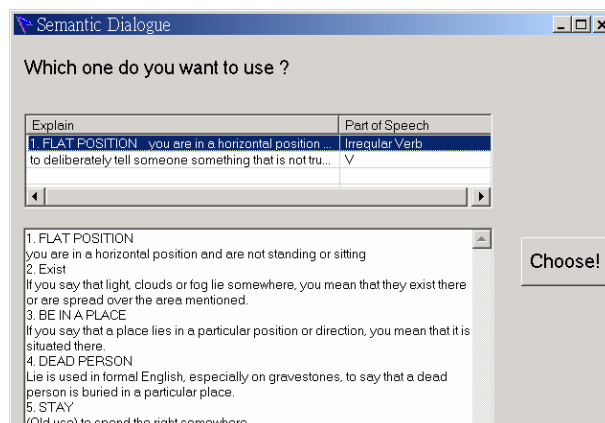


Figure 4. A simple semantic dialogue in the DIT

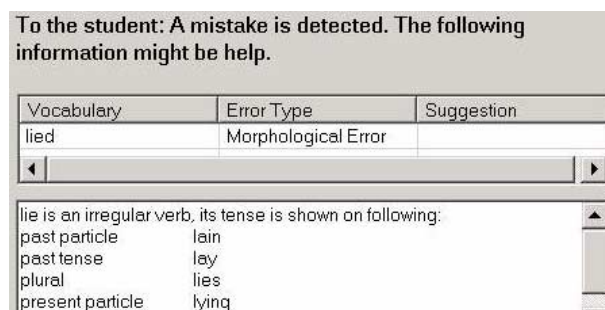


Figure 5. Relevant grammatical information of “lie”

From a pedagogical perspective, treatments include grammar help and exercise. Once the student’s errors are identified, DIT will show the student the error type and related linguistic knowledge (see figure 5).

4: Conclusion

In this paper we illustrated a DIT, which emphasizes generality, modularity, and efficiency as essential design criteria for a pedagogical intelligent tutoring system. The system provides a rich and explicit knowledge representation to assist in lexical problem diagnoses and auto-generating exercise. Moreover, an initial approach of filtering ambiguity is presented to demonstrate how dialogue functions and operates in identifying specific words the students intended to write. In the future, DIT will address grammatical, syntactic errors, and semantic errors.

5: References

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