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An intelligent tutoring system for teaching the grammar of the Arabic language

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Abstract

In this research work, an Intelligent tutoring system (ITS) is presented to simulate the behavior of the educational process. Any intelligent tutoring system consists of a Tutoring Module, a question selector, an Expert Module, a student model, and a graphical user interface. This work is presented in parallel with implementing a project called "Arabic Grammar Tutor" that is appreviated as "AG_TUTOR". A part of this project is adopted and discussed in this paper. This part consists of the first three modules of the ITS. These modules are: the Tutor Module, the Question Selector Module, and the Expert Module. Moreover, the knowledge base and/or domain knowledge will be also conducted. Such modules are implemented and tested. The curriculum of the Arabic grammar of the fourth grade; elementary schools in Egypt; is adopted as a domain knowledge. Moreover, some sort of text analysis will be considered.

Keywords: Intelligent tutoring systems; Tutoring Module; Question Selector Module; Expert Module; Domain knowledge; Arabic grammar

1. Introduction and related work

Different intelligent tutoring systems (ITS) were implemented in several subject domains. Examples of such systems are briefly mentioned as shown below:

There were two ITS projects that functioned based on the conversational dialog: *AutoTutor* and *Why2-Atlas*. Some intelligent tutoring systems were also presented by several researchers. The idea behind those projects and systems was that the programs would begin with leading questions for the students and would give out answers.

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a) *The AutoTutor's* domain is the computer technology. It is a computer tutor that simulates the course patterns and educational techniques of a real human tutor via a dialog with the learner using natural language. It has been developed incrementally where the latter has a 3D interactive interface and has been implemented using visual basic. NET and C# programming language. Using the natural language concept in this project means that the tutoring occurs in the form of a conversation, with human input presented using either voice or free text input. To handle this input, the Auto Tutor project uses computational linguistics algorithms including latent semantic analysis, regular expression matching, and speech act classifiers (Al Emran and Shaalan, 2014).
b) *Why2-Atlas* is an ITS that deals with physics principles as a domain knowledge. The students input their work in paragraph form and the program converts their words into a proof by making assumptions of student beliefs that are based on their explanations. In doing this, misconceptions and incomplete explanations are highlighted. The system then addresses these issues through a dialog with the student and asks the student to correct his/her essay. A number of iterations may take place before the process is completed (Vanlehn et al., 2002).
c) *Web-based Intelligent Language Tutoring Systems (German Tutor)* is constructed to form the grammar practice for a course in German via a web-based environment. Intelligence appeared through a parser that parses the German grammar which is the learner's input. The system's student model provides students with adaptive feedback that is suited to their expertise along with some proposed exercises. Intelligent and adaptive mechanisms were built on a separate server side where the answer is processed. The system has been evaluated through testing it with 19 students within 1 h class. 84% of the students reported that the system was very robust by providing them the immediate feedback and free grammar practice (Al Emran and Shaalan, 2014).
d) *Beetle II System:* is a tutorial dialog system designed to accept unrestricted language input with two different tutorial planning and dialog strategies. The domain of the system is the basics of the electricity and electronics. A natural language dialog parser has been used in order to parse any input from the student as well as to extract an applicable semantics from each statement and identify paraphrases that could bear similar meaning. Beetle II has been implemented to examine whether self-explanation could be handled by computers that are supported by NLP techniques. The system has been developed to ask the learners to illustrate their answers in order to give them a detailed feedback. The system helps to get students into the correct illustration without referring to the short-answer questions and without referring to the tutor after each tutorial response (Dzikovska et al., 2010).

Natural Language Processing (NLP) is one of the artificial intelligence fields which is interested in interpreting and processing human natural languages. NLP researchers aim to gather knowledge on how human beings understand and use language. ITSs vary in their capabilities according to their components and using of NLP tools. Systems use NLP tools have the ability to evaluate the student answer and diagnose his/her misconceptions (Chowdhury, 2003).

Dealing with the linguistic computation of Arabic language is a difficult task. The difficulty comes from many sources: (1) the complex of the Arabic syntax, (2) The omission of vowels in writing Arabic "altashkiil", (3) The free word order nature of Arabic sentence. For those reasons, few researches are involving Arabic-based tutoring systems (Shaalan, 2003).

Our system in this work AG_TUTOR simulates the behavior of instructors and students in the educational environment. AG_TUTOR is considered an adaptive learning system which uses computers as an interactive teaching machine. The system adapts the presentation of educational material according to students' learning needs, as indicated by their responses to questions and tasks. Also, the system has capabilities of NLP to analyze the student answer to diagnose his errors and medicate his problems (Samuelis, 2007).

The tutoring system is executed as a series of tutoring tasks. Each task is implemented using lessons explanation supported with examples and questions (Nkambou et al., 2010). To represent the Arabic grammar in an accurate form, an educational expert and a domain expert from the Ministry of Education in Egypt are consulted. A real academic data course of the Arabic grammar of the fourth grade of elementary schools in Egypt was adopted as a test-bed. In the proposed system, a framework is put for the knowledge base that includes all kinds of the needed knowledge (Mahmoud and Abo El-Hamayed, 2015; Prentzas and Hatzilygeroudis, 2009).

The organization of this paper will be as follows: Section 2 presents the domain knowledge of the AG_TUTOR while Section 3 presents Knowledge Base. Sections 4 and 5 discuss the Tutoring Module and Question Selector Module respectively. Moreover, The Expert Module is presented in Section 6. Finally, Section 7 concludes the whole work.

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