Lupita: Software architecture for virtual characters on the internet and mobile devices

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Abstract. This paper presents educational software based on a math tutor for elementary school children. This software teaches the basics operations of mathematics through a virtual tutor endowed with personality. The virtual tutor is a cognitive agent that integrates a behavioral model, verbal and nonverbal expressions. This architecture was based on the concepts of computing Clouding and RIA (Rich Internet Application) for easy access through Internet and mobile devices.

Keywords: Virtual Character, Intelligent Tutor, Educational Software, Software Architecture, Internet.

1 Introduction

Nowadays the inclusion of mobile devices and Internet in the daily life has a rapid growth and opens a window for developing software with educational purposes.

Educational software can be defined as *"computer programs created with the specific purpose of being used as a teaching tool, to facilitate the teaching and learning"* [1].

Educational software has evolved to providing more facilities and interactivity to the educational process. Simulators, tutors, hypermedia, multimedia and intelligence features are some of the attributes that have been developed in different generations of educational software. The wide incorporation of Internet in the daily life is one of the most revolutionary characteristic that allows the extension of educational applications on mobile devices [2].

The virtual characters seen as an applicative example of educational software for children are having huge boom [3], for this reason it is important a software architecture that provides support for the creation of portable and flexible applications for their inclusion on the Web and mobile devices.

This article describes the software architecture for the intelligent tutor called *Lupita*. This paper is organized as follows. Section 2 discusses the software architecture under the concept of Clouding Computing. Section 3 details the software architecture for intelligent tutor *Lupita*, associated with the concept RIA (Rich Internet Application) for their incorporation on Internet and mobile devices and describes the logic. Then, Section 4 describes the Intelligent Tutor. The paper concludes in Section 5 with a brief summary of our main points.

2   Integrating the concept "Clouding Computing" in an Intelligent Tutor

The concept of *cloud computing* is a new paradigm for software development, which offers the ability to use the infrastructure and platforms that are managed and provided by third parties in order to provide services through Internet.

That is, the user has access to a number of files and programs stored in a place indefinitely, hence the term cloud, which are permanently available independent of where we are. The documents are not physically hosted on a computer and can dispose of them from anywhere with just an Internet connection [4]. There are three types of cloud services [5]:

- **Software as a Service (SAAS)**, which delivers applications such as office applications.
- **The platform as a service (PAAS)**, which provides environments and tools to develop applications, in this case the supplier is responsible for operating the infrastructure (servers, networks, operating systems, the storage media).
- **The infrastructure as a service, (IAAS)**, provides infrastructure for processing, storage, networking and other elements on which customers run their operating systems and applications, and are able to control things such as firewalls or load balancers.

In the cloud, the service platform for Lupita's architecture is provided by Google App Engine also known as GAE, which provides the cloud computing service allowing to create Web applications using Google technology and servers (see Figure 1).

GAE is a platform to develop and host Web applications in data processing centers operated by Google itself. This system has some restrictions, among them that developers have access only to read the file system of App Engine, which runs only with HTTP calls, the storage is limited and Java applications cannot create threads [6].

Figure. 1. *General architecture of system performance under the concept Clouding*

The application development in GAE is supported by the Python programming language.

3 Implementation and Rich Internet Application in the Intelligent Tutor

The Lupita's interface has been created based on the concept of RIA (Rich Internet Applications). RIA is a new type of Web application whose aim is to increase and improve the options and capabilities of traditional Web applications. This new type of applications in most cases are developed using their own markup languages and is performed using a presentation server also own [7].

RIA is highly interactive and with a remarkable visual richness, providing an unprecedented ease of use to web users.

Inside available RIA technologies we found Flash RIA, which is a technology that allows the development of Web applications, these are compiled as SWF files to be executed by the plugin of Macromedia Flash Player. Such applications provide a more attractive and dynamic view [7]. Lupita's interface was developed as a Flash RIA using objects and advanced features accessible through any web application and mobile devices.

Python was the main language used to develop the logic of the intelligent tutor (Lupita), this is an object-oriented programming language [8] and this characteristic has been essential to provide a decentralized and modular implementation of the components.

Lupita is composed of the following modules that interact in order to select math's exercise and give feedback to the student:

- **Cognitive module:** this module allows the selection of the student questions which are influenced by the previous performance of the student.

- **Behavioral Module:** this module endows the virtual character of a personality that will influence their verbal and non verbal behavior during the interactions.
- **Expressive Module** allows communication with AIML[1] enabling verbal and nonverbal expressions of virtual tutor.
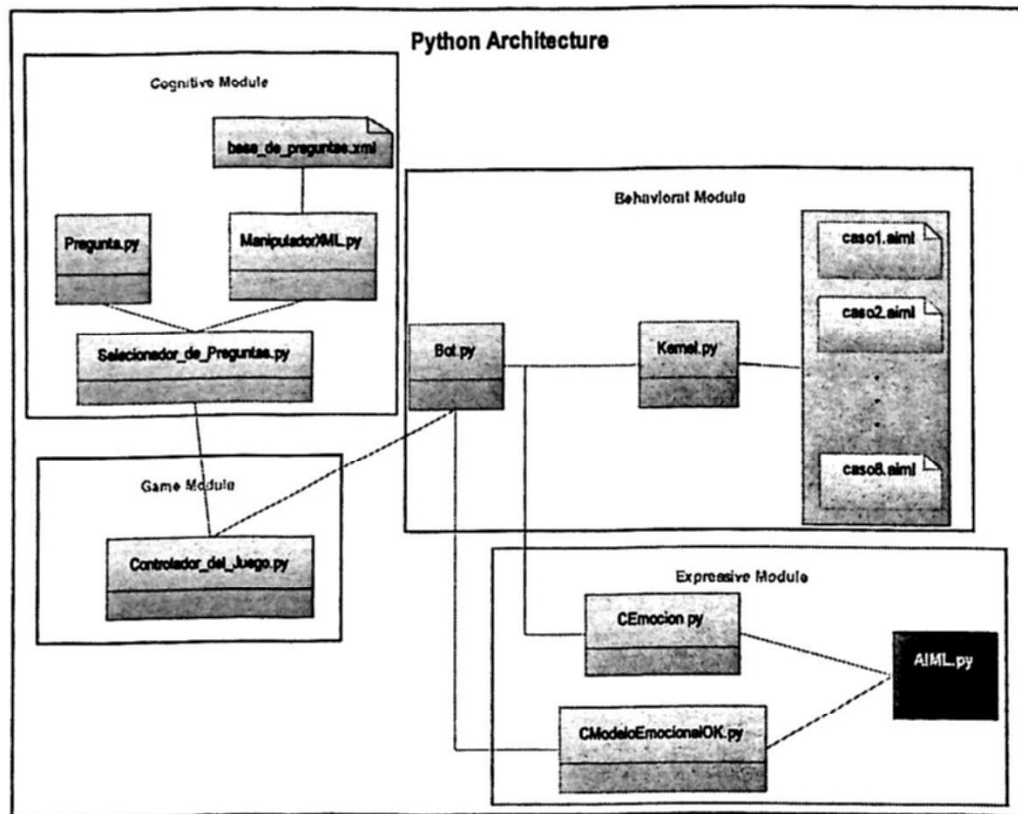- **Game Module:** enables integration of all modules and begins the system execution.

Figure 2. *System Architecture*

4   Intelligent Tutor Lupita

Lupita is an Intelligent Virtual Agent (IVA) endowed with personality that guide an online test related to the basics operations of mathematics. This virtual tutor is a cognitive agent based on the behavioral model proposed by Morales [10], and able to use verbal and nonverbal expressions [11].

The interaction between a user (student) and the Virtual Agent begins when a math's exercise and their possible answers are showed to the student. After this, the behavioral model updates the emotional state of the virtual tutor according to the evaluation of the solution submitted and the time taken to answer it. In order to give a feedback to the student and select a new exercise, these values are processed by the AIML database and

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[1] Artificial Intelligence Markup Language [9].

produce the selection of the next utterance and the non verbal expression. Next, the application interface displays the animation appropriate to the current emotional state of the agent (see fig. 3).
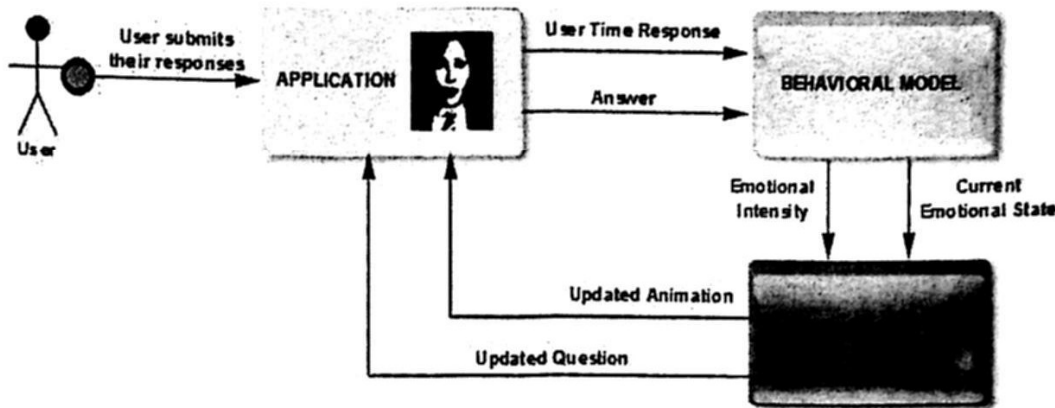

Figure 3. *Interactions in Lupita's architecture*

In the virtual environment Lupita interact as a tutor that aids, assists, encourages and supports the efforts of users to learn.

4.1   Expressions of Nonverbal Interaction on the Virtual Character

Usually the nonverbal expressions in a tutor-student interaction are shown in several stages of the interaction, for example:

* Explain how to solve problems.
* Discuss the nature of the concepts and strategies that are being learned.
* Teaching knowledge.
* Explain the connections between the learning in the present and what is learned in the past.

In our work we modeled and implemented three types of nonverbal expressions which are influenced by the personality profile of the virtual character and the performance of the student:

* Related to the context of the Activity: they are expressions that support, replace or complement messages involved in the educative activities in order to motivate the learning, to hold the attention of the student and to stimulate the good performance.
* Related to the behavior: they imply physical actions or involuntary acts.
* Related to the Social Interaction: they express courtesy protocols, like greetings.

4.2   Prototype of the Math Tutor

Our prototype is educational software based on a tutor for elementary school children, which is available on the Internet at http://www.patylupita.appspot.com/.

The software developed evaluates the basics operations of mathematics through a virtual tutor endowed with personality. In fact, in this prototype the student could chose between two different characters and personalities, Lupita that is a calm person and Paty that is an annoying person (see Fig. 4)

Figure 4. *Tutor selection*

After selecting the tutor, the evaluation interface is displayed (see Fig. 5). This interface is divided between the virtual character and the question-answer area.
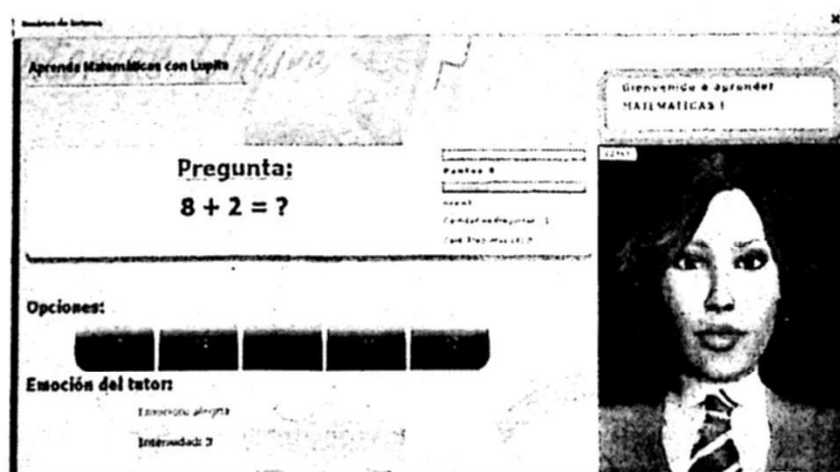

Figure 5. *Example of an interaction with Lupita*

The question-answer area shows additional information related to the level, and the points obtained. The virtual character interacts with the student by text message and nonverbal expression related to its emotional state result of the performance of the student.

5   Conclusions

This work show a new line of educational applications involving virtual characters oriented to teach children. We think that the dynamic interaction with this emotional and social character caught the interest of the student in practice and thus improve their scholar performance.

The present architecture shows the possibility of using the services of the Google infrastructure and RIA technologies for development of educational software that could be easy access through the Internet and mobile devices that support Flash technology.

The main contribution of this work is the development of general software architecture for the creation of applications on Internet and mobile devices that integrates a virtual character endowed by an emotional and social behavioral model.

As future work we want to improve the prototype applying data mining to the performance historic record of the student and thus guide the selection of the next group of exercises that he needs to practice. This new improvement will allow that Lupita will be adaptable to the particular needs of each student.

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