DESIGN OF PROACTIVE SCENARIOS AND RULES FOR ENHANCED E – LEARNING

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Abstract: We show in this position paper how we designed Proactive Scenarios for an automatic and enhanced management of the online assignments on Moodle™ for both student and teacher users, through their implementation with Proactive Rules to be run on top of our prototype Proactive Engine developed for this LMS. According to the diversity of issues that arise from the users activity on LMS, Proactive Scenarios are of two main types, which differ in their main goals, features and complexity. Meta Scenarios are devoted to capture major events of interest and to trigger off the dedicated Target Scenarios, which will undertake the appropriate actions. These Proactive Scenarios will thus take care of specifically predefined situations such as notifications, reminders, problem prevention, user guiding etc. In our opinion, LMS supplemented by such capabilities could provide a boosted effect on the students learning process as it takes an individual approach for each user and therefore could be characterized as a type of intelligent tutoring system. However, in order to sustain or modify the direction of our research activity, we now consider to undertake empirical studies on real-life online courses using the Enhanced e-Learning Platform, which runs our Proactive Scenarios.

1 INTRODUCTION

Learning Management Systems (LMS) or e-learning platforms are dedicated software tools intended to offer a virtual educational and/or training environment online. Currently available types of LMS are fundamentally limited tools. Indeed, these systems have been designed by adapting existing interactive web-based technologies to deliver learning content on user's request, limiting the added value of the LMS to the users own action and not to the needs of the learning process.

Proactive Systems, as defined in (Tennenhouse, 2000), adhere to two premises: working on behalf of, or pro, the user, and acting on their own initiative, without the users explicit command. Proactive behaviours are intended to cause changes, rather than just reacting to changes.

In (Zampunieris, 2008), we introduced a new kind of LMS: Proactive LMS, designed to improve the users online (inter)-actions by providing programmable, automatic and continuous analysis of the users behaviours, augmented with appropriate actions initiated by the LMS itself.

Our Proactive LMS is theoretically able to automatically and continuously help and take care of e-learners with respect to previously defined procedures – called Proactive Scenarios. Thus, our system is capable of detecting an "anomalous" behaviour of e-learner and to communicate the details to concerned e-teacher; or, the system can check automatically the awaited behaviours of e-learners, and react if these actions did not happen. In (Coronado & Zampunieris, 2010) we reported the statistical analysis of studies we conducted in a blended learning environment at the bachelor level. The idea consisted of comparing a study-group and a control-group of students in the same course with respect to their intermediate and final results. Students of the study-group were continuously triggered by hand-made online messages to incite them to participate to the lectures and interact via the LMS. Thus we reported that continuous proactivity supported by the LMS, has direct and positive impact on the students learning process.

In this position paper, we show how we designed various Proactive Scenarios for an automatic and enhanced management of the online assignments sub-system on Moodle™, a free and open source LMS (see moodle.org), for both student and teacher users. We explain as well how scenarios are implemented by means of Proactive Rules and how they are executed through the Rules Engine. Finally, we describe our viewpoints about experimental part of the project where we expect to collect the feedback in order to measure the efficiency of the Proactive Scenarios and thus, to enhance its potential, and to validate the applied research approaches.

2 INTELLIGENT TUTORING SYSTEMS

In the variety of most popular educational theories and learning methods, tutoring approach takes a stable ground and moreover inspires certain researchers to take the concept for further development and implementations.

The statement that learning process is more effective and it has a great potential in a one-to-one way of learning was made by Bloom during his research on adapting teaching. His study discloses that the students tutored by master were more successful in their results with a probability of 98% against the students with instructional type of classroom teaching (Bloom, 1984). The results of this study have opened a variety of directions where this model could be taken for its potential application into another type of the related fields. Thus, the idea of computer assisted instructional programs has already been on the horizon since 1960 (Larkin & Chabay, 1992). However it still needed the further contribution of research efforts. Jaime Carbonell has made the significant change in early 1970s when in his Ph.D. thesis he has adopted the human tutor model into the first intelligent tutoring program SCHOLAR (Carbonell, 1970a, 1970b). The goal of implementation of such analogy related to human – tutor type of learning was to sustain the reasoning activity of a student basing on his or her behaviour. In the later years more and more studies about theories of learning have accentuated the importance of feedback and practice (Kirschner, Sweller, & Clark, 2006). Thus, the research in the field of intelligent tutoring systems through decades has emerged to the dimension where computer science opened the doors to the advantage of joined research efforts that have been built together with the collaborative research in cognitive science (Lesgold et al., 1992).

2.1 E – learning platforms

Learning Management System or LMS was one of the products, which emerged as the deviation from the concept of e-learning and computer assisted instructional programs. Fundamentally it represents an online environment that handles different sides of blended learning such as administrative management and organisation of virtual courses, different learning activities, materials etc. The main goal of e-learning platforms is to track the student's process of learning by facilitating the management of various academic activities.

Taking into consideration all of the advantages of Learning Management Systems, it could be noticed however that the LMS misses the essence of proactive type of behaviour, which could in our opinion significantly increase the outcomes of students' learning process.

2.2 Proactivity as the tool for enhanced e-learning

The notion of Proactive Systems has been introduced by Tennenhouse. He described its functionality as the mechanism, which interacts with the world around it, using sensors and actuators (Tennenhouse, 2000). The sensors' implementation serves as the perception-centre of the system, which is able to capture and observe an event of interest and perform the appropriate actions on its own initiative. The original idea has pushed researchers in computer science to take this approach to another level for further development. Thus, the potential of proactive systems has found a stable ground in the field of Learning Management Systems (LMS).

Proactive or context-aware Learning Management Systems (PLMS) basing on users' activity and its data analysis are capable of acting semi-autonomously or without explicit instructions from the user (Salovaara & Oulasvirta, 2004; Zampunieris, 2006, 2008). Due to advantages of LMS such as integration with other software solutions, we take it into another level where the ordinary e-learning platform will be provided with the proactive type of behaviour (PLMS).

LMS supplemented by such capabilities in our opinion could provide a boosted effect on students' learning process. Considering, on the one hand that this process is a result of collaborative work, it provides the best environment for our Proactive System. On the other hand, the PLMS takes an individual approach for each user (student, teacher, system administrator) and therefore could be characterised as a type of tutoring system.

2.3 Proactive System integration in LMS

The motivation surrounding the enhancement of the learning progress of the students is not new and with the new digital age all old ideas change their shapes into the direction of computerisation. Thus, again, the question how to improve students' academic results has changed to how to help the students in their learning process, by means of new technologies. Certainly we get the good results from implementing these computer-based technologies (Regian et al., 1996). On the other hand what do we get if we combine different types of new computer-based tools with the objective to enhance its productive ratio, for example, in the form of better academic results for the students or better management of the learning content and tasks? Combination of proactivity with the e-learning platform could help or assist user while he or she performs certain tasks in LMS environment. In its totality, the PLMS represents a groupware tool, which aims to boost the online academic activity of a student as well as the effectiveness of their learning process by providing a variety of proactive scenarios, which potentially covers all possible situations arising from different activities and tasks.

2.4 Prototype of PLMS on Moodle™

This project has a premise that the proactive engine will be embedded into Moodle™, the e-learning platform currently used at the University of Luxembourg. That decision allows the research team to focus on the design and implementation of Proactive Engine, using existing LMS as a framework.

As shown in the Figure 1, the core of the Proactive System is the Rules Engine in addition to the rules themselves. The first is responsible for the control flow of the rules execution where the rules represent the implementation of the proactive scenarios' logic. Each rule is implemented in a separate Java class. The idea of the Rules Engine is to add the proactive behaviour to the LMS, but not to change its code or to restrict its execution. Several parameters were introduced in (Zampunieris, 2006) in order to configure the PLMS system in a way that the main core functions of LMS and Proactive System don't overload the host computer. Hereafter are the examples of mentioned parameters: (F) - Time frequency of its activation periods; (N) - The (maximum) number of rules it runs in an activation period. We also introduced a third parameter to ensure that our system doesn't interfere with the LMS main process: (P) - The (minimum) time Proactive System pauses between two activation periods.

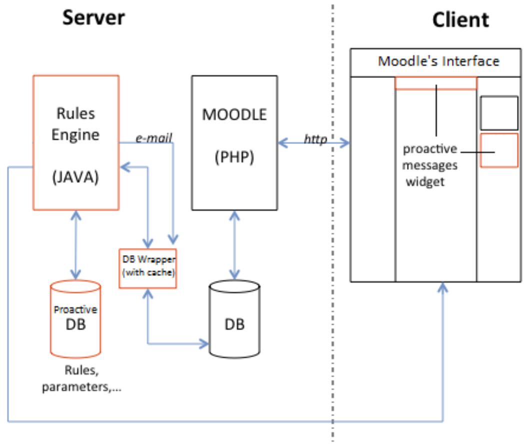

Figure 1: System Architecture

The Rules Engine acts as it was defined in (Zampunieris, 2008), where it is responsible for storing the set of rules. It also stores a second list of rules that represents the rules generated in the current activation period. This second list will be added at the end to the remaining set of rules (in case the system parameter (N) has been reached), in order to be executed in the next activation period.

The interaction with Moodle™ is done via its database, where Proactive System checks changes of its state, relevant to the scenarios' logic. To that effect, we developed an abstract database wrapper, with two implementations: MySQL (with the textual SQL queries needed to access Moodle's data) and MySQL with a cache on top of the first one (applying the Proxy Design Pattern). We ensure the persistence of the Rules Engine by using the Hibernate™ framework to store the rules' queue, the generated messages and some system statistics, on a specific database schema. As for interacting with the user, the system sends emails and/or messages embedded into the LMS system, depending on whether the user is online or offline. We are currently developing the Moodle™ add-on, which permits the user to interact with our system's messages. We are working as well on the administrator's interface, which will include such menu functions as starting/stopping the engine, and changing the system parameters.

3 PROACTIVE SCENARIOS

Proactive System is the goal-oriented mechanism, which entails a set of scenarios with an objective to provide a help to the user or the tutor according to their activity on LMS. The scenarios have different areas of application; it typifies the nature and its main operational directions. According to the diversity of issues that arise from the user's activity on LMS, the scenarios may differ in its features, essence, and complexity.

Two types define the category of Proactive Scenarios: type #1 are the Meta Scenarios, and type #2 are the Target Scenarios.

3.1 Type #1: Meta Scenarios

The goal of scenario of type #1 is to provide the system with feature of the perception-centre. That is, to capture an event of interest and to undertake the appropriate actions.

In order to activate the specific scenario, which will correspond to the actual situation of the user's activity, the system needs to be aware about the current state of the LMS database. As the Target Scenarios have not the capability to detect any changes on LMS but only perform the specific job, this role is attributed to the so-called *Meta Scenarios*. The main functionality of this type of scenario is to be context aware continuous never-ending rule. As soon as the Meta Scenario detects the corresponding event on the LMS, it activates the Target Scenarios, which will do the predefined actions or in different words the Meta Scenario will delegate the specific job to the appropriate scenarios.

Basic type of implementation of Meta Scenarios is the system environment of LMS. It means that this type of scenario will provide our system with the interactions between user and Proactive System as well as Proactive System and LMS database. The actions of Meta Scenario are characterised as inward related. However, the effect of these actions is mostly oriented on the outer user's environment.

3.2 Type #2: Target Scenarios

The goal of scenario of type #2 is to provide the multiple target responses to each detected by Meta Scenario event or non-event.

In metaphorical perspective, the scenarios of type #2 are to be the hands of the Proactive System. They are responsible for the single target actions that have been initiated by the Meta Scenarios. The type #2 takes care only of specifically predefined situations such as *Notifications* that aim to inform a user about an event, *Reminders*, *Problem prevention*, *User guiding* etc. Taking into the account that all scenarios are nothing else as the set of rules, after having performed its individual job each rule becomes dismissed. This is the radical difference between two types of scenarios. When Meta Scenario is defined to be the never-ending rule, the Target Scenario simply dies after each completed task. It permits to optimize our system in terms of memory usage.

In the similar perspective as for the Meta Scenarios, the Target Scenarios have their own areas of application. The basic characteristic of the rules employment of that type is its outward direction of the actions. In our case the focus is defined by three different orientations: system administrator environment, e-teacher environment, and e-student environment. Thus, while creating new scenarios and rules we try to maximize the accuracy of the defined actions' outcome of the Proactive System and to better respond on the detected need arisen from the users actions. In order to do so, we have to pay an attention on the cognitive aspect of user's intentions, objectives, and actions.

3.3 Use of joined approaches

One of the main objectives of the study is to build the scientific evidence for the outcomes of our research activity. Thus, we found the combination of two different domains, computer science and cognitive science, beneficial.

While working on the Proactive Scenarios we have to analyse the perspective of different cognitive approaches in the users' behaviour or, in other words the specific context related activity in order to provide the response from our Proactive System with the accurate actions based on the user-oriented methods of cognitive expertise. Different cognitive theories, which are outlined below, are applied during this process. We believe that the results issued from the joined approaches may provide us with the objective and accurately grounded scientific evidence for the further research efforts in this field.

The following brief description of the concept theories used in our research, highlights the main orientations that we consider currently in the process of planning and creating the proactive scenarios and rules.

Cognitive approach and Behavioural science
This theory provides us with possibility to study and to display the user's behaviour while working online, to help us to build the schema of possible users actions in specific situations and accordingly to implement these aspects into the Proactive Scenarios (Burnes, 2005; Gao et al., 2002).

Theory of socially shared cognition is linked to the theory of *Computer-user interactions*, and will display the aspects of computer-mediated interactions, synchronous or asynchronous. By taking the examples from social interactions and studying them we could find the equivalent type of application in human-computer interactions (Siler, 2009; Wrede et al., 2010; Yeh et al., 2007).

Activity theory is partially linked to the theory of *Socially shared cognition* and will help us to display the aspects of how learning takes place basing on the *Higher mental functions theory* of Vygotsky (Nardi, 1996; Vygotsky, 1981).

The theory of *User's identity* gives us the picture of the average user where we define his/her fundamental behavioural patterns and apply them into the proactive scenarios (Rowe, 2010; Zimmerman, 1998).

3.4 Map representation of scenarios connections

Figure 2 provides the visual representation of all scenarios connections in the form of a decision tree. It shows the process of how one Meta Scenario according to the captured data from the inward system environment or outer user environment launches several Target Scenarios. The hierarchy of Proactive Scenarios is indicated by the specific colour, which distinguishes and regroups the similar layers in one category.

Thus, all Meta Scenarios abbreviated as MTA basing on specific parameters deploy the appropriate path of actions though the set of Target Scenarios. As soon as the subjected task is accomplished, the proactive process jumps back to the level of Meta Scenarios where it continues to look for the new data.

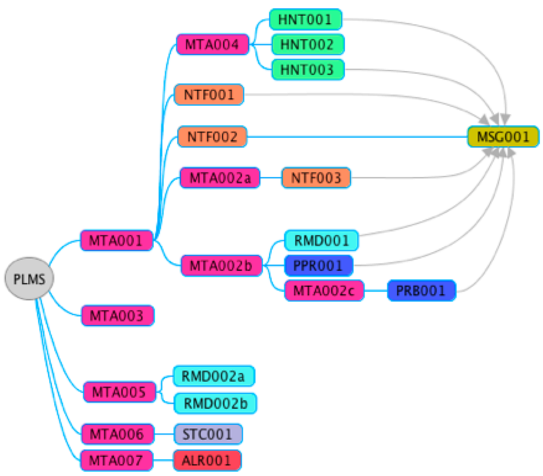

Figure 2: Generic representation of scenarios

4 FUTURE EFFORTS

While creating the new unverified yet technology, there is a need for the testing and validation of the ideas, theories, and potential results derived from the archetypal phase of the research project. Thus, in order to sustain or modify the direction of our research activity, we consider to undertake the empirical study and the analysis of the data issued from the upcoming experiments.

The sessions of experiments will take place between February and June of 2012 at the University of Luxembourg. The participants of the experiment are the students enrolled to the bachelor program at the faculty of *Computer Science and Communications*.

The goals of the experiments are divided into two modules. The first aims to improve our Proactive System's functionality with the particular emphasis on Queue Manager, User Interface, Messaging System, and elaboration of Proactive Scenarios. For the second module the objective is to enhance the students' success level in online virtual academic activity as well as to boost their learning process. In order to do so, we divided main goal into the subcategories of specific objectives such as students' e-learning practice, their cooperative and collaborative learning skills, learning competences, learning experience, and learning performance.

Thus, at the present moment we develop the measurement tools, which allow us to test each category and subcategory of the defined goals of the experiments. Such measurement tools aim to collect the feedback from the users whether automatically through the statistics reports of the system or manually through online surveys, interviews, questionnaires, and live discussions. For some categories of experiment we will use the similar technics as in (Coronado & Zampunieris, 2010).

We assume that this experiment will help us to detect the potential research gaps and to enhance the probability of valid and constructive outcomes.

5 CONCLUSIONS

The position paper describes the main concepts of the Proactive System. Implemented into the Moodle™, it aims to enhance the capabilities of LMS by enriching its main functions with the proactive type of behaviour. As reported in previous experiments, the feature of proactivity has positive reflection on e-learning experience of the students.

According to the diversity of issues that arise from the users activity on LMS, Proactive Scenarios are of two main types, which differ in their main goals, features and complexity. Meta Scenarios are devoted to capture major events of interest and to trigger off the dedicated Target Scenarios, which will undertake the appropriate actions. These Proactive Scenarios will thus take care of specifically predefined situations such as notifications, reminders, problem prevention, user guiding etc. In our opinion, LMS supplemented by such capabilities could provide a boosted effect on the students learning process as this Proactive LMS takes an individual approach for each user and therefore could be characterised as a type of intelligent tutoring system. However, in order to sustain or modify the direction of our research activity, we now consider to undertake empirical studies on real-life online courses using the enhanced e-learning platform, which runs our Proactive Scenarios. We expect to collect the feedback in order to measure the efficiency of the Proactive Scenarios and thus, to enhance its potential, and to validate the applied research approaches.

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