Personalized, Adaptive and Intelligent Support for Online Assignments Based on Proactive Computing

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We designed and implemented a prototype software system based on proactive computing, as an add-on to existing technology enhanced learning platforms. In this paper, we show how our proactive engine augmented with the adequate proactive scenarios enhances the assignments sub-system of the Moodle™ learning management system by providing personalized, adaptive and intelligent support to both online learners and teachers.

Personalized and adaptive software systems; technology enhanced learning; proactive computing

I. INTRODUCTION

Currently available learning management systems (LMS) or technology enhanced learning platforms are basically limited tools as they were designed by adapting existing interactive Web-based technologies to deliver content on user's request. These tools wait for an instruction and then react to the user request, limiting the added value of LMS to the user's own action and not to the needs of the learning process. Users could imagine and hope for more help and assistance tools, based on an intelligent analysis of their (lack of) actions. LMS should tend to offer some personal, immediate and appropriate support like teachers do in classrooms. In [6] a new kind of LMS is proposed: proactive computing based LMS, designed to help their users to better interact online by providing programmable, automatic and continuous analyses of users' interactions, augmented with appropriate actions initiated by the LMS itself. Proactive systems, as defined in [5], adhere to two premises: working on behalf of, or pro, the user, and acting on their own initiative, without user's explicit command. Proactive behaviors are intended to cause changes, rather than just to react to changes.

The rest of the paper is organized as follows: we will first briefly explain how our prototype proactive system is implemented as an add-on to the Moodle™ LMS (see www.moodle.org), and also what are proactive scenarios and how they run on it. Second, in a sequence and on the basis of examples around the assignments sub-system (see [1] for some arguments in favor of this choice) of the LMS, we will show how our prototype augmented with the adequate proactive scenarios can provide automatic and continuous support to the online users, which is personalized, adaptive and intelligent. Finally, we will draw an overview of the ongoing and future developments around our current works.

II. IMPLEMENTATION

Our proactive system prototype was designed to be added to an existing LMS in order to create a personalized and adaptive tool for technology enhanced learning (see [3] for more details). The premise being that our system does not modify the native LMS, but takes advantage of its functionalities (*eg*. to send local emails) and its data. This means that the interaction of our system with the LMS is done exclusively via its database, where the proactive engine checks for state changes which are relevant to the scenarios. The core of the proactive system is a rules-based engine, as described in [6]. The engine is responsible for the actual running of the proactive rules and their flow of control, while the rules encode the logic of the proactive scenarios. Scenarios may be based on events or absence of events over a period of time and may differ in their features, essence and complexity, according to the diversity of issues that arise from the user's activity on the LMS.

Note that our approach is different than the one proposed in [2] that also deals with extending LMS with adaptability but which requires three extensions in the architecture of the original LMS in order to integrate the proposed framework. Our system does not – the native LMS software and database keep unchanged – and thus provides a generic solution.

III. PERSONALIZED SUPPORT

When some running proactive meta-scenario detects the major event it was looking for, it starts adequate proactive scenarios which will be in charge of taking care of several support procedures in the future with respect to this major event that occurred. Most of these scenarios are user-centric and will activate individual and specific actions and/or messages with respect to both the support procedures and to what the user will do (and not do) in the future. Hence, our system provides true personalized support as not only can it take care of each user individually, but also as it will continuously adapt its behavior for each user according to what he/she does (or not) over a period of time.

Examples in our proof-of-concept implementation are when a meta-scenario detects the creation of a new online assignment on the LMS by Prof. P for the class C:

1) Scenarios are started for Prof. P, some in order to regularly inform him/her of completion statistics of the assignment by the set of students S, also some in order to warn him/her of detected issues that he/she could take care

of, like *eg*. one student in the class C did not even read the needed documents for being able to answer the assignment after some days, *etc*.

2) Scenarios are started for each student S in the class C, some in order to periodically send S reminder messages (on-screen or by email) while he/she did not complete the assignment, also some to provide help to S like additional useful references and/or hints after some pre-determined period if the assignment is still not complete yet, *etc*.

IV. ADAPTIVE SUPPORT

The rules-based proactive computing engine is designed so that only the necessary and pertinent rules are kept and/or generated for the future – the other ones are discarded. This way, proactive scenarios which are deprecated because they reached their goals are automatically deleted from the system, and new scenarios can be started on purpose depending on the current context. The number and types of rules in the engine up to the present time are dynamically adjusted to the constraints of support procedures, but also to the future needs of the users with respect to their current and past actions. Thus our proactive system is context-aware and could be qualified as adaptive to its users. Examples are:

1) Scenarios are started to help a student who already received proactive reminder(s) for an assignment and did not react yet, these scenarios will replace the preliminary reminder-sending scenarios and will send adequate and on-purpose incentive messages to the student.

2) Scenarios are started to keep an eye on a student who already received proactive reminder(s) for an assignment and did not react yet, so that his/her Professor or e-tutor will be notified if needed after the student received intelligent proactive support (see Section V).

Please note that our approach of adaptive support can be merged with the approach proposed in [4] where an intelligent LMS is aimed at adapting the course to the learning preferences of each student. Indeed, to proactively provide context-aware and pertinent support messages to students while they study online is complementary to dynamically provide them with matched course contents according to their learning styles.

V. INTELLIGENT SUPPORT

Our proactive support system is not only able to provide individual and adapted support to each user as we explained before, but is also able to provide real coaching of the users, as well as to prevent problems (related to users actions) from occurring, thanks to smart and complex proactive scenarios. In that sense, our system provides intelligent support to its users. Examples in our proof-of-concept implementation are:

1) Scenarios are devoted to guide a student step-by-step when he/she receives new assignment in order to coach him, *eg*. to record important dates for this assignment in his/her LMS agenda, to send him/her links to adequate documents and references (provided these data have been stated by the Professor before, of course), to send him/her reminders if necessary, to send him/her hints for the answer after a while, to show him/her incentives like the number of students in the class who already answered it, *etc*.

2) Scenarios are devoted to inform as soon as possible the Professor who created a new assignment for some class, that this particular student will eventually fail to answer the request and/or will most probably provide a weak answer if the Professor does not react soon in order to remediate to the current e-student's situation, for the student already received reminder, help, hint and coaching messages from the proactive system but his/her online behavior on the LMS is not yet adequate to have chances to succeed in the assignment... and the deadline is approaching.

This last example of intelligent support to the Professor will help him/her to concentrate on possible problems inside his/her online class, instead of wasting time searching in log files and database views in order to try to find out what the students did (or not) over the last day(s) and figure out where are the potential needs of additional academic support.

VI. CONCLUSION AND FUTURE WORK

In this paper, we showed how our proactive system augmented with the adequate proactive scenarios enhances the assignments sub-system of the Moodle™ LMS by providing personalized, adaptive and intelligent support to both the online learners and teachers. Live experiments are ongoing in our university, and the feedbacks will help us to improve the tools as well as the proactive scenarios. As our proactive engine is generic and does not require any change to the main software application it supports, these results could be easily translated to other technology enhanced learning platforms. We also plan to design, implement and validate new kind of proactive scenarios in order to enhance other functions of LMS, as well as adding new functions to LMS like computer-supported collaborative learning through the proactive and context-aware dynamic management of networks of interest among e-learners. The ultimate goal is the creation of a truly social, personal and adaptive online learning environment, as it is also envisioned in [4].

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