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Integrating Automatic Task Scheduling and Web-based Agenda in a Virtual Campus Environment

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Abstract

This article describes an activity and time management tool that allows any member of a virtual learning environment to have their timetables and activities planned or scheduled in such a way, that deadlines and personal preference criteria are both met. First of all, a general overview of the day-to-day difficulties that students, particularly distant learners or e-learners, face when dealing with the organization of the different steps of their learning process, is given. It focuses then on the benefits that an integrated planning/scheduling environment means, introducing our solution: the intelligent agenda. Some of the main features provided are described, paying special attention to the definition of restrictions to be considered and fed to the scheduling process, as well as to the mechanisms to make the task - empty timeslot allocation. As a result, the output of the process will be graphically represented in the user's web agenda, which will appear populated with the new activities scheduled according always to an optimum, in terms of time, timetable or distribution. Finally, some conclusions derived from the implementation of the tool are given.

1. Introduction

The proliferation of all type of e-learning resources, such as virtual campuses or online courses, has made of this educational-offer the most popular option for distant-learners and a very tempting one for students eager to round off their curricula.

The problem is that, nowadays, despite the huge amount of distant learning tools available in any virtual campus environment, there is still a serious lack of integration between them and existing time management and task scheduling tools. Something that, considering the difficulties that both students and faculty members face when trying to arrange the set of tasks to accomplish or to make compatible their timetables, brings out the need to provide them with the mechanisms to optimize the use of an increasingly scarcer time-availability.

The main goal pursued with the work described in the article is explaining the development of a web-based intelligent agenda specifically aimed to satisfy needs associated with distant learning techniques in virtual environments; a tool that overcomes the limitations, regarding task scheduling techniques, displayed by traditional electronic diaries that are, in general terms, a mere translation to the digital world of common use paper desk diaries. This is possible because task planning is made directly from inside campus environment and thus, at the moment of the scheduling, all activities that have been programmed for a given user by either members of campus teaching staff or management staff are known; the user does not have to introduce them one by one before proceeding! To evaluate the performance of the main capabilities of the system, an implementation of this tool will be integrated within the virtual campus structure of the University of the Basque Country. This first prototype or implementation will allow assessing the acceptance and success of the tool among its users after its usage, as well as the degree of effectiveness obtained from the application of the proposed scheduling methods in a real/production environment.

2. The e-Learning Environment

2.1. The Challenge

Nowadays, while nobody questions the potential benefits of Internet as the leading factor for the development of new future sceneries in education, using virtual learning environments (VLE) still poses important educational issues for universities. It is becoming more and more clear not just that reproducing traditional

methods and translating course material to electronic formats is not enough in pedagogical terms but also that the mistakes of the past could easily be duplicated in a new guise [1].

The clearest difference between presential education and virtual education lies in the available means and in the educational potential derived from the effective use of them. Obviously, we can not try to do the same with different means even if our educational purposes and, consequently, the results pursued are the same; that, would lead to falling into the same mistakes mentioned beforehand.

The learning process in virtual or distant environments is the result of a process in which it is the student the one in charge of *building* its knowledge [2]. That is the reason why the key to success seems to lay on a new paradigm of virtual campuses, campuses that should make a real effort to adapt their materials and resources to become learner-centered rather than content-centered.

Nowadays, almost any virtual learning center offers an available range of educational means (communication tools, multimedia resources, etc.) wide enough not to represent a differential element to make potential users favor one or another environment simply taking this as a base.

Taking all this into account, virtual campuses can not limit themselves to an extensive offer of non-related tools and need to go one step further to give real solutions to all participants, offering integrating tools that combine the capacities and strengths of many resources and that are suitable for all members of their communities, not just for a few.

2.2. The Participants

No doubt, knowing the audience towards whom one's efforts are aimed does make a difference. In fact, for the success of any virtual learning environment, this knowledge represents the cornerstone of their marketing. Potential students, leaving aside for a moment virtual campus community members that fall into other professional categories, can be grouped into the following different profiles [3]:

- **Adult Learners**: referring to those that share their time between a professional occupation and their studies. Conversely to what used to be common a few years ago, these learners are aware that learning is integral to their success on their jobs and that they must learn all of their lives.

- **Traditional Campus Learners**: considering as such, those who are enrolled into a traditional presential course in university and who supplement it by studying one or more subjects through online resources.

- **Virtual Campus Learners**: those who complete a whole degree using electronic and network resources and do not have any professional occupation.

The first two groups show similar characteristics regarding the difficulties that might arise when trying to organize their timetables for an efficient learning; they both have to fit the courses' learning exigencies, in terms of time devoted to the development of certain types of activities either individual or to be accomplished in team, into an already rather crowded agenda.

The third group, on the other hand, when trying to fulfill a given number of work-assignments or tasks may probably have a greater need of guidance in the moment of deciding when to accomplish each of them, the intensity of the effort devoted, etc. The scheduling of the tasks should somehow play the role of a tutor or counselor helping them to program their learning sessions.

In any case all groups, including administrative and teaching staff in virtual campuses, share a clear common need for a tool or figure that helps them organize their daily activities together with academic ones. There are a number of such organizing tools, commercial as well as open ones, but the main weakness that these electronic diaries or calendars show is that they are not integrated at all within the working or learning structures and, consequently, users are forced to introduce manually each of the task to accomplish together with the exact date to execute it.

2.3. The Integrating Element

One of the strongest points of the proposed tool, besides the fact that the task scheduling mechanism is not a common feature in web-based calendar managers or electronic diaries, lies in its surrounding framework. The tool is fitted within a whole task-planning environment that allows an easy management. To do so, different user types have been defined (managers, teachers, students) and profile-based privileges are used to grant full or limited access to certain functionalities.

Through graphic web-interfaces users from the upper classes in the defined hierarchy, campus managers or teachers, are able to define independent o grouped tasks that might be targeted to either individuals or groups of people belonging to lower levels of the hierarchy tree.

The main benefit of such environment is that the feeding of the scheduling process can be made directly from the tasks stored in a database structure. Users' sole

responsibility is performing an adequate selection of those tasks, among the ones that have been addressed to them, that they want to accomplish in a near future and, again, this is done from a web interface.

This characteristic frees users from the tedious work of having to feed into the system all possible activities one by one each time they want to reschedule their agenda; something necessary in non-integrated environments. Moreover, users do not have to make up beforehand which ones they should carry out, since only relevant information will be displayed.

3. Components of the Intelligent Agenda

The architecture of the intelligent agenda consists of five modules:

- Database
- Web Server + JSP/Servlet Engine
- Mail Server
- Supervision/Control Module
- Planning and Scheduling Module

These modules comprise all essential functionalities to conform an integrated framework such as the one described starting from scratch. Consequently, for its future integration within production platform, some of them will not need to be installed requiring only minimum configuration.

The database structure together with the planning/scheduling module and supervision/control module represent the core of the system, therefore their main features will be briefly reviewed. Detailed information on system's architecture for further reference can be found at [4].

3.1 Database Module

The most remarkable feature of the design is that it provides flexibility to make the tool extensible for future integration in other environments.

This flexibility has been achieved by implementing a general-purpose planning/scheduling environment represented by a group of tables generic enough to suit into almost any specific environment.

Similarly, another set of tables has been defined to characterize a virtual learning environment with all its representative attributes.

All the information used for planning or scheduling purposes is stored within the table structure of the generic environment but coded accordingly to represent valid information for our specific environment.

Maintaining this division allows a possible future quicker migration of the tool to other environments. This is possible because the heart of the tool operates, as explained, against a generic cluster of tables that remains unchanged no matter what the application field is.

How the information regarding personal diaries and trees of tasks is stored and reproduced in memory to be treated will be of great importance for correct running and operation of the scheduler.

3.2. Supervision and Control Module

The supervision and control module takes care of the mechanisms used to generate different types of e-mail based messages to users of the intelligent agenda, namely invitations to take part in other users' personal activities and specially system notifications.

System notifications will be addressed to users, for example, when tasks in which they have enrolled approach their deadlines, to let them know that they should have been already completed.

This control is implemented through a number of periodic processes that go all over the tasks in the system and that are triggered according to prearranged landmarks. Landmarks are settled during the learning process in answer to suit both students' and teachers/managers' requirements and may signal the imminence of different sorts of events.

3.3 Planning and Scheduling Module

The planning and scheduling module is divided into three main areas or submodules: the representation or agenda interface, the task management submodule and the scheduling submodule.

As both the agenda interface and the scheduling will be treated below, a brief outline of the mechanisms that the management submodule performs will be given.

3.3.1 Management Submodule

This submodule comprises all the processes to manage the load of programmable tasks in the system; administrative management, i.e., matriculation procedures, group, student, course management, etc. are made outside the agenda but within the virtual environment frame that hosts it. Mechanisms are related so that it is ensured that all the results from the processes have an immediate direct reflection on the planning structure, maintaining the consistency of its information.

As stated, planning task management implies mechanisms to enter, eliminate or modify entries that will populate later on virtual campus members' agendas, and

that constitute the primer input to the algorithms used in the scheduling/arrangement submodule.

4. Scheduling process

It is understood that scheduling is concerned with deciding *when* to carry out a given set of tasks, so as to satisfy various types of constraints related to the order in which tasks need to be performed during a fixed given period.

To continue, a more in depth analysis of the scheduling process, detailing how and from which data it is fed and what outputs does it throw, is made.

4.1 Inputs of the scheduling process

In figure 1 it is manifest that four types of inputs are fed to the scheduling mechanism and that these inputs can be grouped according to their subsequent use during the process: finding out available time slots in a user's diary or arranging selected tasks to answer for scheduling preference criteria.

After those two steps have been accomplished, the process will just have to map each task or portion of task to a certain timeslot.

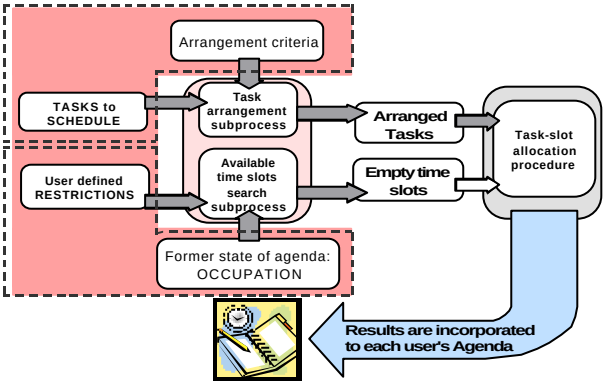

Figure 1: Flow Diagram of the Scheduling Mechanism

4.1.1 Empty time-slot availability

For the correct operation of the scheduling tool the process to find out user's time availability is undeniably crucial. In our scheduler this information is collected from two different sources: the user's agenda itself and the user-defined restrictions for the scheduling.

- **User's agenda:** it stores previously allocated time slots that have to be taken out, and not considered, for all future allocation processes. These slots can represent either personal activities noted in the diary, entries that are never fed to the scheduling process as other tasks because they have an associated fixed date to be executed, or entries resulting from previous task scheduling processes. Additionally, the database structure that holds users' diaries can also contain other sort of entries: *blinding* entries that account for forbidden time intervals not applicable for scheduling purposes in user's agendas.

- **User-defined Restrictions**: similarly to blinding entries, these restrictions *mark* certain areas of users' diaries as *reserved*. This sense of reservation is wider than the one explained before; it allows blocking areas so that no scheduling is considered in them, but also permits to leave aside these time slots and allocate them just for tasks of a certain nature, for example for developing activities related to a given course. Finally, these user-defined restrictions can be either static or dynamic, depending on whether they are supplied just once, to be considered in all further scheduling, or if they are applicable only to current process.

Table 1: Example of weekly diary with fixed allocations.

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
7am-8am							
8am-9am							
9am-10am		Coffee	Coffee	Coffee	Coffee	Coffee	
10am-11am							
11am-12pm							
12pm-1pm							
1pm-2pm		Lunch	Lunch	Lunch	Lunch	Lunch	
2pm-3pm							
3pm-4pm							
4pm-5pm							
5pm-6pm							
6pm-7pm		Paddle		Paddle			
7pm-8pm							

Table 2: Sample blinding entries to prevent scheduling in given areas of the diary or limit it to specified tasks.

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
7am-8am							
8am-9am							
9am-10am							
10am-11am							
11am-12pm							
12pm-1pm							
1pm-2pm							
2pm-3pm			Operating Systems		Operating Systems		
3pm-4pm							
4pm-5pm							
5pm-6pm							
6pm-7pm							
7pm-8pm							

4.1.2 Task Arrangement Criteria

The amount and attributes (type, duration, course reference) of the tasks to be scheduled is as important as the time availability itself. When performing scheduling it is necessary to allocate tasks obeying predefined

preference criteria (those that are bound to finish soon first, then those with highest priority, etc.). And the way to be able to do so is by having a sorted set of tasks and start to search available slots in meticulous order. Evidently, to proceed both the tasks and the criteria for ranging then are needed.

- **Tasks to be scheduled:** they are selected from the ones listed in the scheduling dialog pages of the tool. It is important to remember that only relevant information will be displayed, i.e., information regarding *active* tasks (those for which current date is comprised between the task's starting date and its deadline). Thus, accessing to these dialogs at different points during the course year may throw different results in the offer or range of tasks to be done.

- **Sorting criteria:** After selection has been done, a number of parameters to consider for ranging will be defined: task priority, subject, activity type, etc. Nevertheless, since the scheduler implements a time optimisation scheduling approach, it is always necessary to perform a previous analysis that guarantees that there will not be cases in which tasks' deadlines are missed. If deadlines were to be missed to fulfil user-defined preferences, the system will have to notify that minimum scheduling conditions are not met.

4.2 The task-timeslot allocation

With all the inputs the processes are ready to start. First of all, in both cases, the tool will not work directly over the registers of the database. Instead, it will create a tree representation of the data in memory; one for the fraction of the diary that is used to schedule and another to reproduce user's task hierarchy.

The tree representing the diary will have as many roots as weeks considered for the scheduling, and from each of these roots will hang branches for days, hours and quarters of hour (the smallest of the timeslots handled). Each of the bifurcations will keep information about total time available in the downstream, and the use of the blinding entries will be equivalent to doing some kind of pruning in the tree. This *count* information will be used as well to test if there are enough timeslots comprised in the selected interval to proceed with the scheduling.

A similar structure is employed to represent tasks, as tasks may or may not be independent; some tasks will be directly affected by the fulfillment of others.

The allocation of one task to one or more consecutive timeslots will cause the pruning of the branches and an update in the available time value kept in the whole upstream.

4.3. Output of the scheduling process

Once the allocation has been completed the system will provide a simulation of the scheduling results, showing the proposed task distribution through its calendar web interface. If the user accepts the performed scheduling, the database information will be updated and, moreover if they want to, users will be able to define another set of parameters for a new scheduling.

5. Conclusions

This paper has introduced some of the benefits that integrating automatic task scheduling mechanisms within a web-based agenda may report to potential users of virtual learning environments. All these users share increasingly demanding timing requirements to combine and fit educational tasks in their daily routines. And they all face a common necessity to be able to manage and schedule their workloads efficiently from an integrated interface, a feature that current commercial solutions do not provide.

An specific solution designed to be applied in virtual environments of such integrating framework in the e-learning environment of the University of the Basque Country's Virtual Campus has been presented, and preliminary results show that the use of these kind of tools could grant a new and better way of organising student and professors' agendas while studying and teaching through VLEs.

As future research lines, it is intended to test this tool in other virtual environments where it will be proved whether its design is fully adaptable to changeable working conditions.

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