E-SERVICES FOR THE BETTER CITIZENS LIFE: THE SCHOOL'S EXAMPLE AND INTEGRATION WITH E-GOVERNMENT

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Abstract: Distance learning is constantly reaching a new level. Its coverage, content, and significance for everyday life are difficult to overestimate today. Those projects that are aimed directly at providing online communication and training services have taken off. Learning management systems have become very popular. Thanks to its functionality, which allows you to support the learning process, monitor homework, conduct online communication and monitor the progress of homework and the ability to evaluate them. And if in small groups scheduling is not necessary, then for schools and universities the basic functionality of learning management systems is not enough. It becomes clear that for the convenient conduct of the educational process, educational institutions and universities lack the functionality for personnel management, such as planning (scheduling) and reporting.

In this article, we offer a developed solution that will help solve the problem described above and ensure quality scheduling at school or university, taking into account the requirements, restrictions and wishes of the administration of the institution. An innovative approach has been applied to the learning management system (LMS).

The proposed solution is based on previously known techniques for managing employee change. Following the implementation of the relevant annex, the first positive feedback was received from Iraqi schools where the decision was implemented. All the above circumstances provide grounds for further development and improvement of the system. The article focuses on the implementation of the module of planning and scheduling in the learning

management system. The importance and prospects of such implementation are indicated.

The article also outlines the context of the task, ie the scope. The prototype of the really existing system is shown. Thus, we managed to develop a functional application that can be adapted to any needs of the educational institution. E-government services are mentioned and the possibility and need for integration of these services is shown.

Introduction

The first step on the path to online learning was the transition from streaming content via CDs to online. The network was originally used only as a means of distribution. The content was still monolithic, that is, intended for certain programs and virtually indivisible. To use the first educational online programs, the user had to download certain developer programs. Navigation and information systems did not always work in all environments.

In the development of the second generation of content management systems, it became obvious the need to separate content from its representing programs, and the creation of learning management systems (Learning Management Systems). With regard to quality standards in LMS, given the development of IT and the increasing use of these environments, it is important to identify those that meet the minimum requirements. These requirements can be expressed in reliability, scalability, safety, sustainability and adoption of international quality standards.

Scale is needed to attend a large number of students, which is a fundamental characteristic of e-learning. But it is impossible to achieve scale without the help of scheduling. Planning is a complex and important task in the learning environment. Establishing work schedules to manage the working hours of employees in educational institutions is one of the key factors of stability for the Contact Centers and other companies that have work organization based on change [Chernichenko, 2016], [Lytvynenko, 2015], [Panchenko, 2003], [Panchenko2, 2003], [Panchenko, 2004].

As for schools and universities, the class schedule is one of the important documents that governs the educational process. At the entrance we have:

• "restrictions": restrictions relate to the time of classes, their sequence, sequence and the maximum number of classes per day / week;

• "requirements": this parameter characterizes the workload of each teacher (or teacher) - the number of hours and what subjects will need to be taught for a certain period of time;

• "wishes": this characteristic is not key in scheduling in case of high workload of all teachers. However, if necessary, it can take into account the wishes regarding the date and time of the lesson (for example, in case of illness, vacation, training).

• "locations": depending on the type of lesson, the system selects the most convenient classrooms or classes.

Also, in the case of scheduling for a school or university, an additional important interchangeability requirement should be considered (or, a kind of flexibility in understanding scheduling change management). We mean that changes (another teacher or class, or to move a class to another day of the week or another time) should be made on request at no additional cost to the planning manager.

It is important to note that such functionality can rarely be seen in systems aimed at supporting the learning process [AlHilali, 2015], [AlHilali, 2016], [Aggrwal, 2018], [Nagar, 2018]. This task is not a priority for the LMS, which is primarily a Learning Content Management System (LMS) and is primarily intended for managing the content and structure of the courses. But the main reason for such avoidance is the relative complexity of the task. This task is quite complex without obvious advantages for the developer.

Therefore, the task is to make a schedule that would meet all the above requirements.

Approaches to automated scheduling

Today, there are a number of approaches to building an automated schedule. Much depends on the specifics of a particular task. Thus, CPU time planning is different from WorkForce Management (WFM), ie scheduling shifts. Usually Markov processes, algorithms of "brute force" (full search), optimized search algorithms, genetic algorithms are used to create a graph [Panchenko, 2003], [Panchenko2, 2003], [Panchenko, 2004]. Machine learning methods [Panchenko, 2003], [Panchenko2, 2003] and gradient descent methods can

also be used here. We will try to improve the flexibility of the schedule by introducing an innovative method into the generation process.

Complete search algorithms have become popular because of their simplicity, but they require a lot of computational time. With large variations in the input data (more than 100 employees, many different activities - classes in our case - etc.), the process may become inapplicable in real time. Due to this fact, many optimizations and heuristics appear, which help to reduce the required computing power and consider only the best cases due to a set of predefined heuristics. Moreover, gradient descent optimization was applied to further simplify the full search algorithm.

The goal is to create a school schedule that is flexible enough for further change management and meets the above requirements and constraints as much as possible.

Of course, this level of flexibility requires additional resources. To do this, we need:

        • the availability of additional teachers who can teach a certain lesson (say, geometry for 7th graders) to replace another teacher who was supposed to teach in that class but could not come for some reason,

        • availability of additional audiences to simplify the implementation of the "location" parameter for our application.

A handy visual tool to support this kind of change and visualize the effects of change is also needed.

Developed an application for scheduling

We developed our application on the foundation of the WFM system, which turned out to be in line with the ideas behind the foundation, although it was not obvious in advance. WFM program planning solves the problem of assigning employees (contact center operators) to changes, where the schedule of changes is formed from the previous stage of resource planning and forecasting the number of staff for each specific time period of the week [Panchenko, 2003],

[Panchenko2, 2003], [Panchenko, 2004]. (Time periods are usually hours, half-hours, or a quarter of an hour.)

The weekly classic schedule for the school is presented in Fig. 1.

Fig. 1 - Classic schedule in the school

Thus, the classical form of the compiled schedule is presented in Fig. 1, which provides a detailed ("expanded") view of one day and an overview of the week as a whole.

The schedule in our application for school is presented in Fig. 2. and Fig. 3. The system interface is quite different from Fig. 1, but if we look at these schedules from the point of view of the teacher, we get almost the same picture. Moreover, as we noted earlier, the requirements and approaches to scheduling are very similar.
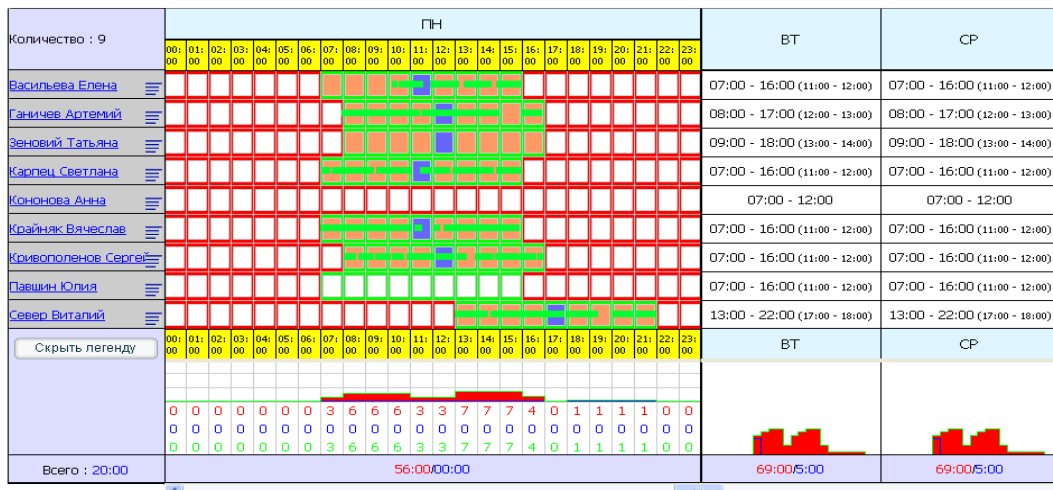
Fig. 2 - Daily schedule of teachers
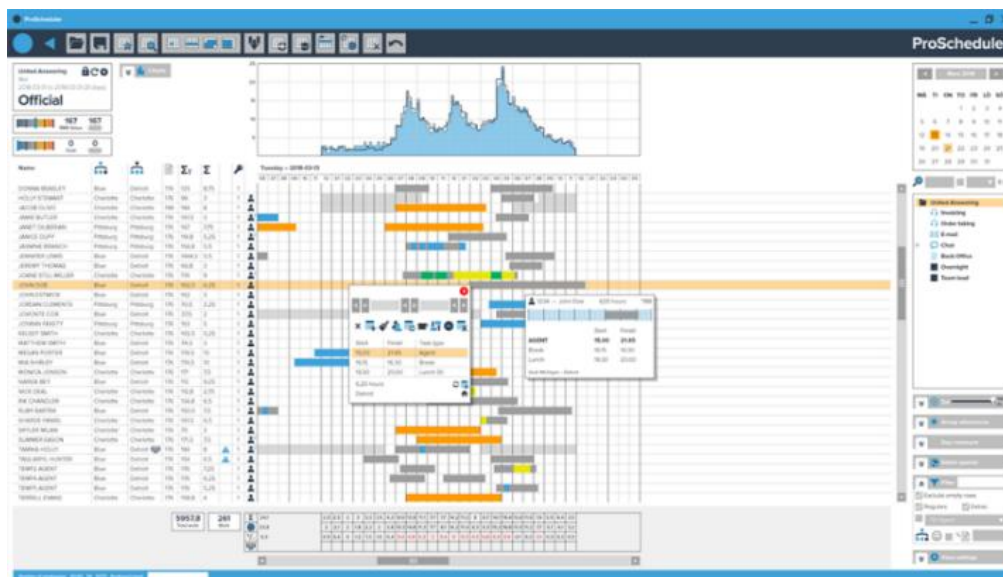
Fig. 3 - Interface of the weekly schedule and workload of teachers in the application

So, we have developed new software based on workforce planning principles. To develop MVP (minimum viable product), we used an optimized full search algorithm for scheduling, leaving a deeper search optimization for further development. This application is part of the learning management system, which is already on Beta test and is being implemented in two schools in Baghdad. Currently, the authors are collecting feedback to improve the system and move on to developing new planned features.

The main modules of the developed application are:

- planner,
- viewing the schedule for different roles: teacher, weekly class schedule, classroom load,
- change management subsystem,
- API for integration with external LMS,
- API for data exchange.

The first feedback from users is positive, so we continue to further develop the developed application.

Further plans include the implementation of more sophisticated approaches to better schedule (for the resources needed to accomplish this task). We would like to make this software more convenient and adaptable to different types of scheduling restrictions. Also, the system needs to be more integrated into the learning process, which involves the development of an open source application for external developers who will be interested in developing additional functionality - system modules.

Integrations and further work

Here we would like to state that the integration between e-Government portal and this developed and proposed LMS with unique additional functions have been started. This integration includes the following directions:

• exchange of resources used in schools from the government for the teaching,

• the load of teachers and their interconnection in schools through classes and common resources,

• the schedule in classes and thus the possibility to check the difference in schools and divergence of one from another.

Of course, there we listed not all possible ways of interconnection and information exchange. Open Data allows to use broad range of algorithms and optimizations to improve the teaching and management quality, and, thus, we

hope, the citizens lives [Bakhouyi, 2019], [Alhawawsha, 2019]. Fig. 4 presents the very high level, general plan of this new work.

Fig. 4 – Interconnection API for School and e-Government e-Services

Conclusion

So, we have developed new software based on workforce planning principles. To develop MVP (minimum viable product), we used an optimized full search algorithm for scheduling, leaving a deeper search optimization for further development. This application is part of the learning management system, which is already on Beta test and is being implemented in two schools in Baghdad. Currently, the authors are collecting feedback to improve the system and move on to developing new planned features.

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As to the integration to the broader context and with the country-wide or ministry-wide services, we are going to organize it via the e-Government API. This way the next features will be obtained:

• centralized schedule view on the country level,

• good understanding of resources involved in schools,

• clear view of how many classes being held by teachers, level, school and other parameters,

• better information exchange between all stakeholders.

Bibliography

[Aggrwal, 2018] AGGRWAL, A., VERMA, R., SINGH, A. (2018): An Efficient Approach for Resource Allocations using Hybrid Scheduling and Optimization in Distributed System, "International Journal of Education and Management Engineering (IJEME)", Vol.8, No.3, pp. 33-42

[Alhawawsha, 2019] Alhawawsha M. Open Data Platform Architecture and its Advantages for an Open E-Government / Mohammad Alhawawsha, Taras Panchenko // Advances in Computer Science for Engineering and Education (Advances in Intelligent Systems Series, Z.B. Hu, S. Petoukhov, I. Dychka, M. He Eds.). – 2019. – Issue 1247. – P. 258-266.

[AlHilali, 2015] AL-HILALI, Z.S.H. (2015): Programmed, distant, mobile learning… what's next? "Bulletin of Taras Shevchenko National University of Kyiv; Series Physics & Mathematics", No. 4, pp. 75-81

[AlHilali, 2016] AL-HILALI, Z.S.H., SHEVCHENKO, V.P. (2016): The structure of e-Learning system for the discrete mathematics. In Proc.: "Theoretical and Applied Aspects in Program System Development (TAAPSD'2016)", Kyiv, pp. 252-256

[Bakhouyi, 2019] Bakhouyi A. A Semantic Web Solution for Enhancing the Interoperability of E-Learning Systems by Using Next Generation of SCORM Specifications / A. Bakhouyi, R. Dehbi, M. Banane. // In: Ezziyyani M. (eds) Advanced Intelligent Systems for Sustainable Development (AI2SD'2019). AI2SD 2019. Advances in Intelligent Systems and Computing, Springer. – 2019. – №1102. – C. 56–67.

[Chernichenko, 2016] CHERNICHENKO, K., KAPKANETS, A., PANCHENKO, T. (2016): Contact center load forecasting and operator schedule planning, "Problems of Programming", No. 2-3, pp. 227-236

[Lytvynenko, 2015] LYTVYNENKO, T.I., PANCHENKO, T.V., REDKO, V.D. (2015): Sales Forecasting using Data Mining Methods, "Bulletin of Taras Shevchenko National University of Kyiv; Series Physics & Mathematics", No. 4, pp.148-155

[Nagar, 2018] NAGAR, R., GUPTA, D.K., SINGH, R.M. (2018): Time Effective Workflow Scheduling using Genetic Algorithm in Cloud Computing, "International Journal of Information Technology and Computer Science (IJITCS)", Vol.10, No.1, pp. 68-75

[Panchenko, 2003] PANCHENKO, I. (2003): An Alternative to the Erlang C Formula, "Corporate Systems", (Kyiv), No.2, pp. 57-59.

[Panchenko, 2004] PANCHENKO, I., PANCHENKO, T. (2004) Optimization of Call-Center Using Automated Computer System Scheduling ISS v.1 [in Ukrainian]. In Proceedings of the International Conference "Theoretical and Applied Aspects of Program Systems Development". Kyiv. pp. 272-274

[Panchenko2, 2003] PANCHENKO, I. (2003): Computer Modelling of the Mass Service Task, In Proc. Int. Conference "Informational research, applications and the study", Varna, FOI-COMERC, pp. 55-61

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