

University Class Schedule Management Information System Project*

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Abstract

The article examines an IT project for developing an information system to manage a university class schedule. The proposed concept has several advantages over analogous products, one is the ability to generate schedules based on teachers' preferences using artificial intelligence. This approach is particularly relevant when artificial intelligence systems are integrated into various software products to improve employee productivity. Within the framework of the IT project, the analysis examined approaches and methods to create the most user-friendly interface for the modular program. The article highlights the problem of the complexity of scheduling classes, taking into account the fact that academic staff teach at different faculties. The IT project leverages modern technologies and methodologies to ensure stability, high performance, security, user-friendliness, and modularity. Database design has been implemented, along with the modelling of business processes of the information system, which are presented as UML diagrams for use cases, classes, and states, allowing for clear visualization of the system's architecture, component interactions, and data flow between different modules.

Keywords

IT project, higher education institution, class schedule, information system, UML diagrams, artificial intelligence

1. Introduction

With the rapid development of information technology and the growth of data volumes, developing and implementing effective information systems for managing class schedules in higher education institutions is gaining importance. Traditional methods of schedule creation are generally labour-intensive, inefficient, and prone to errors, leading to suboptimal use of university resources, inconvenience for students and lecturers, and a decline in the quality of the educational process. Automating this process with the help of specialized information systems allows not only the optimization of the allocation of learning resources but also the assurance of flexibility and responsiveness in responding to changes, which is critical in a dynamic educational environment. In addition, such systems help to improve communication between participants in the learning process, providing quick access to up-to-date information and the ability to make changes quickly.

Class schedule management systems significantly simplify and accelerate the schedule creation process, thereby reducing lecturers' workloads. Implementing these systems in universities provides more optimal schedule formation and accurate recommendations, which positively affect class attendance and student motivation.

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Developing an IT project for an information system to manage class schedules requires a deep understanding of the needs of higher education institutions and other educational establishments and knowledge of the methods and technologies used to create efficient and user-friendly software products. Modern optimization algorithms and data analysis methods allow for considering numerous factors, such as room availability, lecturers' preferences, student workload, and others, significantly improving the generated schedule's quality. Implementing such systems is an important step toward the digital transformation of education, contributing to increased efficiency in managing the educational process and enhancing the overall quality of education.

2. Formulation of the problem

A wide range of offerings characterizes the market for class schedule management information systems in higher education institutions; however, most existing solutions do not meet modern requirements for flexibility and personalization. This creates a significant problem for universities that aim to manage class schedules effectively, optimize resource utilization, integrate the system with other information platforms, and provide a user-friendly interface.

Modern higher education institutions face several challenges related to class schedule management. Existing information systems' insufficient flexibility and personalization capabilities complicate adaptation to each institution's unique needs. The use of information systems that can be tailored to an educational institution's specific needs is an important motivating factor for the administration. Therefore, there is a need to develop flexible and modular systems that simplify the class schedule management process without compromising the security and speed of the final product.

The relevance of this issue is driven by the continuous growth in data volumes and the need to optimize management processes in universities. Implementing effective information systems for managing class schedules will not only improve the organization of the educational process but also enhance the satisfaction of both students and lecturers and ensure a more efficient use of university resources.

3. Analysis of recent studies and publications

The class schedule is a key instrument in regulating the academic activities of students and lecturers in higher education institutions. Forming an optimal schedule requires considering several critical factors, including adherence to educational curricula, adequate working conditions for the teaching staff, balanced distribution of academic workload, and effective utilization of classroom resources.

Analysis of current schedule formation processes reveals that the document flow, which directly impacts the quality of the final schedule, is typically conducted manually using traditional paper documents or files in arbitrary formats. This process becomes even more challenging due to the complex organizational structure of higher education institutions, which includes numerous academic buildings, classrooms, majors, and groups. Therefore, automating the schedule formation process is not feasible without addressing issues related to document flow organization. Consequently, when developing automated schedule formation systems, special attention should be devoted to optimizing and standardizing the document flow.

In work [1], the issue of developing software components designed to automate the schedule formation process in higher education institutions is addressed. As part of the study, a web application that provides schedule formation functionality was designed. The application uses PHP and JavaScript as a Single-Page Application (SPA) website. In the subsequent stage, full implementation of this application is planned, along with testing and integrating additional features to optimize the schedule management process.

The authors of the study [2] developed a client schedule for the education of students in higher education institutions. The developed information system includes a model of the system itself, an algorithm for its operation, support for Android and iOS platforms, a designed data schema for the

system, and a flexible, intuitive user interface with the option to select various design elements. However, the system requires improvements in remote operation and administration.

Article [3] proposes a software product that significantly simplifies document flow and the schedule formation process in higher education institutions. The system's architecture, database structure, document element recognition algorithms, and ready-made forms for selecting criteria options for schedule formation are demonstrated.

Aida-Zade K. et al. [4] developed an algorithm and software for an interactive class schedule creation system for universities that have joined the Bologna Process. This system takes into account the specifics of the credit-module learning system. The proposed system covers the entire cycle of integrating students into groups for studying selected subjects and with assigned lecturers, starting from creating lecturers' schedules and student registration and culminating in forming individual schedules for each student.

According to research [5], students of Western Sydney University exhibit varying performance indicators depending on the time their classes are held. Specifically, students who attended morning lectures (8:00–10:00) experienced more academic failures than those who attended classes later. Students best received the course material during lectures held from 10:00 to 12:00.

Paper [6], an analysis was conducted on the impact of class schedules on student attendance and academic results. Results obtained using Educational Data Mining on a large dataset from Prince Sultan University revealed that students who skip classes due to ambiguous scheduling tend to have significantly lower performance indicators. The correlational study indicates that student attendance is strongly related to the class schedule. In particular, the average number of missed lectures directly impacted students' average grades, highlighting the recommendation to use information systems for schedule formation.

Despite the existence of some ready-made solutions for automating the schedule formation process, modern approaches to developing class schedule systems must include the use of optimization algorithms that enable the discovery of optimal solutions while considering numerous constraints and requirements. In addition, the application of machine learning and artificial intelligence technologies will allow for automated data analysis and the consideration of the individual needs of the participants in the educational process.

4. Formulation of the purpose of the article

The purpose of the article is to develop and design an information system for managing a university's class schedule, which will be able to automatically generate the timetable based on teachers' preferences using algorithms and artificial intelligence technologies.

The goal of the IT project is to create an efficient and user-friendly tool that will simplify university staff work by allowing them to create high-quality class schedules more quickly. This, in turn, will reduce the time spent organizing the educational process and increase its efficiency. This approach will also allow for considering individual teachers' needs and optimizing the educational process.

The primary objective of the developed information system is to assist educational institutions in creating class schedules, thereby contributing to improving the quality of educational services. The system is intended to reduce administrative workload, ensure flexibility and accuracy in planning, and enhance the satisfaction of both teachers and students.

5. Presenting the main material

Information systems for managing class schedules are designed to automate planning and organizing timetables for educational classes in academic institutions. They provide a convenient and effective way to distribute class hours, consider the needs of teachers and students, and optimize the use of classrooms and resources. Thanks to intelligent algorithms and artificial intelligence capabilities, such systems can automatically create a timetable that

maximally accommodates teachers' preferences, avoids scheduling conflicts, and improves the overall efficiency of the educational process. In addition, they allow for easy modifications to the timetable in response to unforeseen circumstances, ensuring transparency and accessibility of information for all participants in the educational process.

Before developing the software product, it is necessary to analyze its market counterparts, highlighting their advantages and disadvantages. Table 1 presents the advantages of our IT project over similar products, namely Astra Schedule, Open EduCat, and SchoolTool [7, 8, 9].

Table 1

Comparison of the IT project with analogues

Characteristics	Our project	Astra Schedule	Open EduCat	SchoolTool
Modern security	Yes	No	No	No
Expansion speed	Yes	Yes	Yes	Yes
Speed of work	Yes	No	No	No
Accounting of premises	Yes	Yes	Yes	No
Scheduling	Yes	Yes	Yes	Yes
Auto-generation	Yes	Yes	Yes	Yes
User management	Yes	Yes	Yes	Yes
Taking into account the wishes of teachers	Yes	No	No	Yes
Analytics	Yes	Yes	Yes	Yes
Code modifications	Yes	No	Yes	Yes
Integration with other systems	Yes	Yes	Yes	Yes

Based on the analysis, it can be concluded that the class schedule management information system being designed has the potential to be more competitive in the market due to better implementation of some key features, such as modern security and operational speed.

When designing information systems, the primary focus is determining exactly how the IT project will be used. To this end, a UML use case diagram has been constructed, which allows for the identification of the main operation scenarios and system users, as well as the functional requirements for the application (Fig. 1).

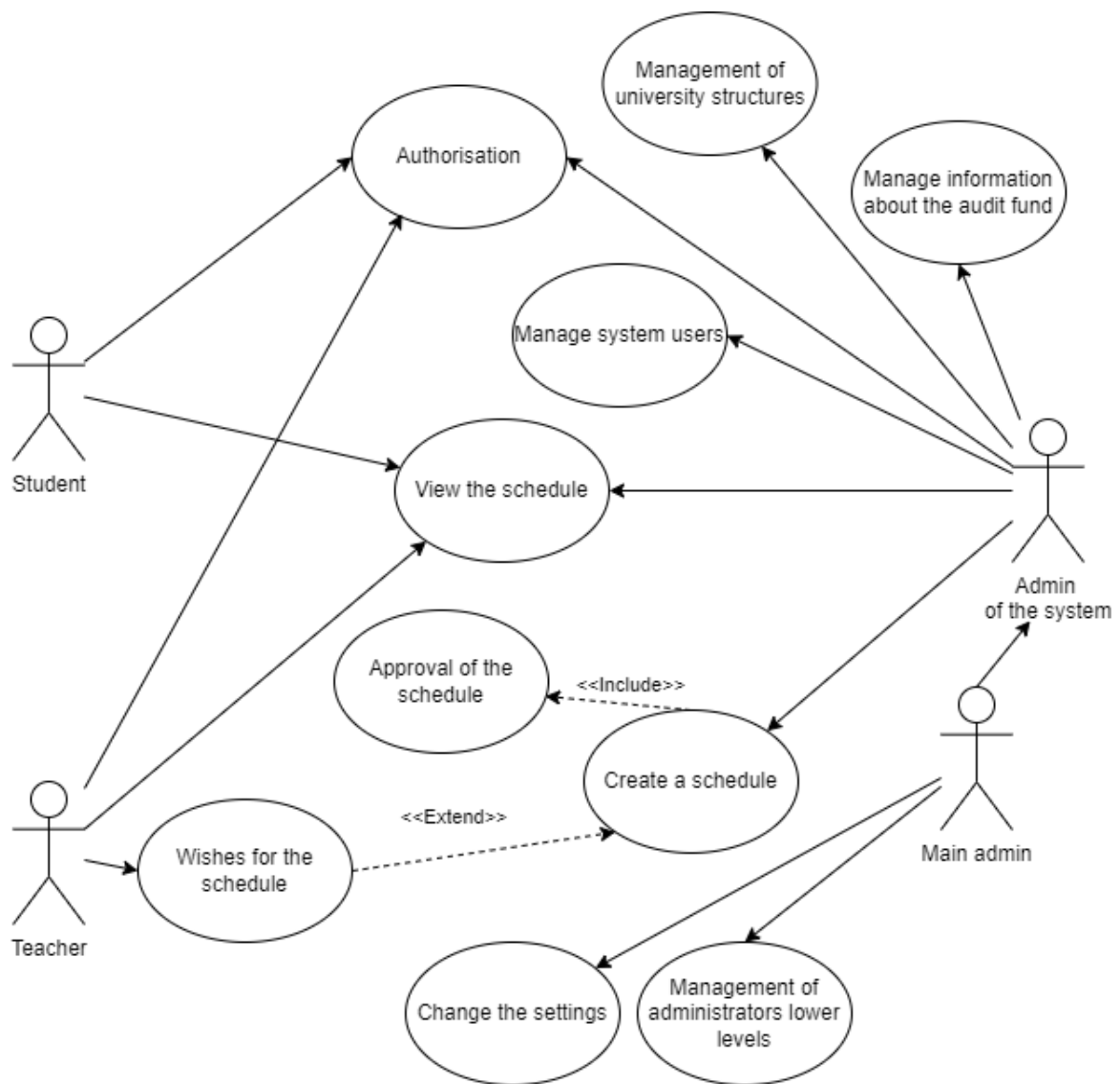


Figure 1: UML use case diagram.

Based on the information provided by the use-case diagram, it is possible to infer what specific data the class schedule management information system will work with and to design a database for storing information on the server. Figure 2 illustrates the physical data model of the information system's database.



Figure 2: Physical database model.

It is important to note that while SQL databases are a reliable way to store data, they are not the best option for quick data access. Therefore, NoSQL databases are often used alongside them. Considering the functionality of the information system and the structure of the database, a good option is to use the Redis data store to organize fast access to data using a key-value approach. This will significantly speed up the system's performance and be beneficial for developing a schedule analysis algorithm.

The hashes that will be created in Redis to provide faster access to data are presented in Table 2.

Table 2
Hash data structures stored in Redis

Name	Key shared with main database	Key type	List of fields
User	No	string	password, user_id, access
schedule	No	UUID	day, classes_id
classes	No	UUID	t_s_id, time, audience_id, link
subject	Yes	UUID	name, type
teacher_subject	Yes	UUID	teacher_id, subject_id
group_subject	Yes	UUID	group_id, subject_id
schedule_wish	No	UUID	t_s_id, groupe_id, wish_formatted
group	Yes	UUID	students_num
audience	Yes	UUID	places_num

Based on the main functional requirements of the IT project and the database architecture, the architecture of the classes of the information system can be designed more precisely using a class diagram (Fig. 3).

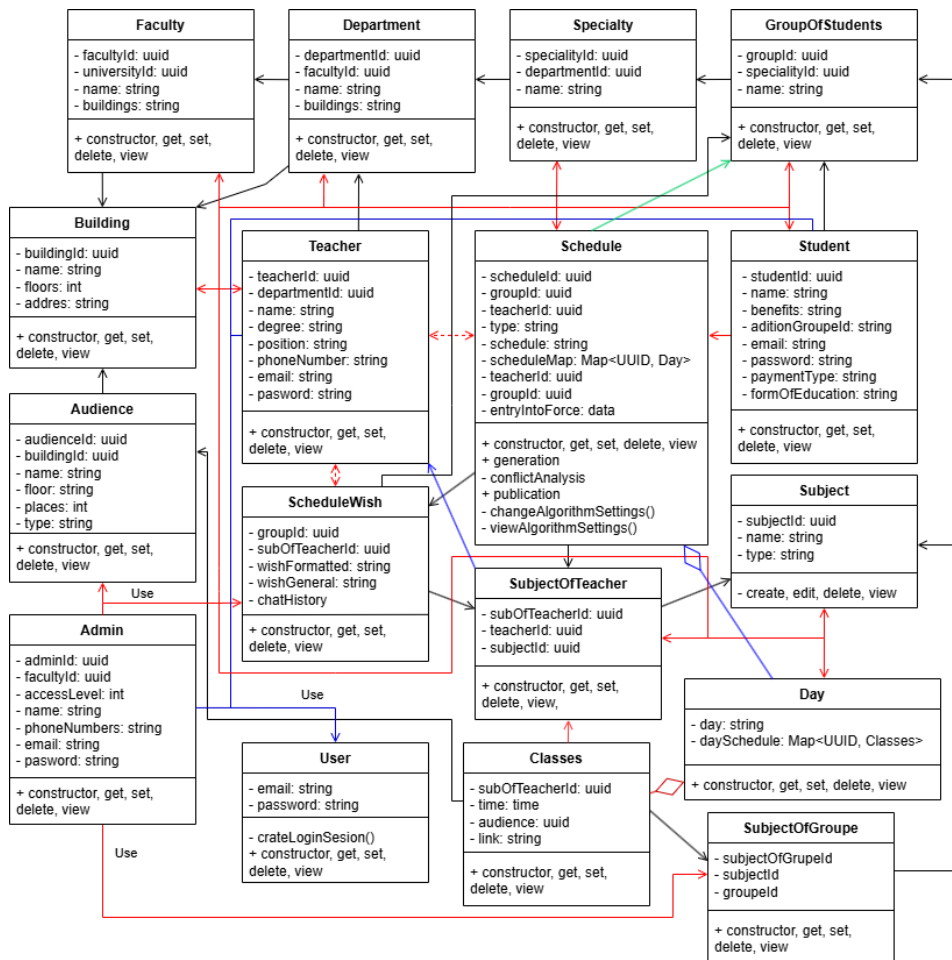


Figure 3: UML diagram of object classes.

Analysis of Figure 3 shows that almost every class contains methods such as constructor, get, set, delete, and view, which briefly describe the basic functionality of the classes. The "Classes" and "Day" classes are designed for more convenient data management in Redis to facilitate the operation of schedule generation algorithms and conflict analysis. Depending on the settings, the "Generation" and "conflictAnalysis" methods can use built-in algorithms and artificial intelligence either separately or together – in other words, AI has access to all the information, just like the algorithms. The system also supports continuous AI training based on approved schedules or using a version without this option.

Figure 4 illustrates the UML diagram of the overall functionality of the university class schedule management information system.

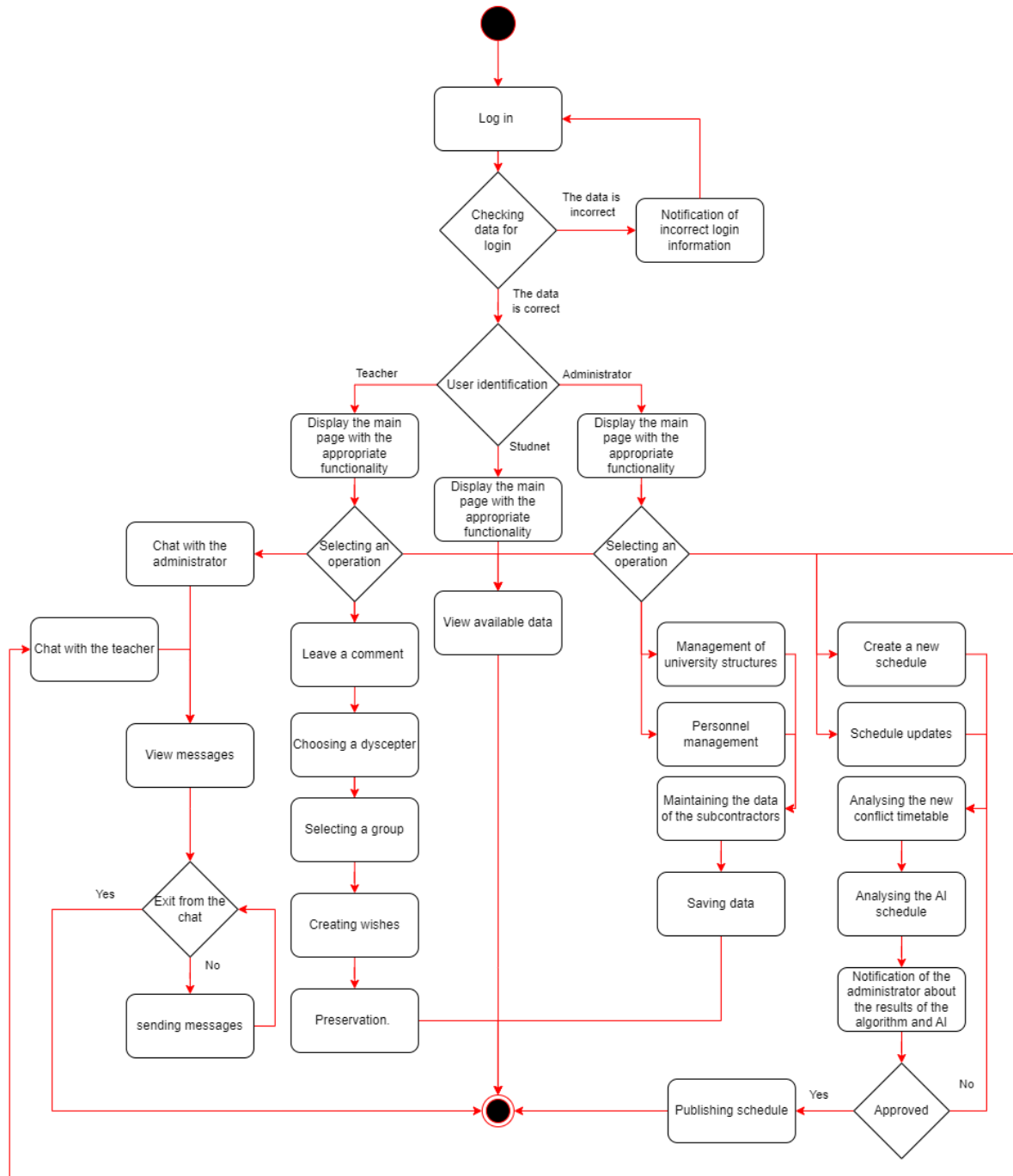


Figure 4: UML states diagram.

The university class schedule management information system features a modular, scalable, secure, reliable, and high-performing design. This study focuses on developing a system that meets these requirements while considering technology choices that ultimately determine its architecture and performance. By providing a choice between the existing system and its adaptation to the requirements and structure of the higher education institution, new users will be encouraged, which should significantly increase the IT project's competitive ability in the market.

The core backend functionality is developed using Golang, ensuring efficiency and scalability. The artificial intelligence components are implemented in Python, taking advantage of its powerful machine-learning libraries. Data storage is handled by the PostgreSQL SQL database, while Redis, due to its simplicity and widespread popularity, is used for caching and fast data storage. This combination of technologies contributes to the information system's rapid development, reliability, speed, and security.

For the frontend, technologies such as HTML, CSS, SCSS, React, TypeScript, and Next.js create a modern, intuitive, and secure user interface. These technologies enable the development of dynamic and responsive web applications that meet high standards of quality and security.

In the IT project, comprehensive testing of the class schedule management information system, including several stages, is also planned. First, unit testing verifies each system component individually, ensuring proper functioning. After that, integration testing is carried out to assess the interactions between different modules and components, identify potential conflicts, and detect compatibility issues. Next, system testing will examine the entire system as a whole, evaluating its operability, performance, stability, and security. Finally, acceptance testing will be aimed at verifying that the system meets the requirements of both users and the business, as well as confirming its readiness for real-world operation. Additionally, load testing is planned to determine the system's maximum capacity to handle high volumes of simultaneous requests and data processing. All types of testing will be carried out using both automated test scenarios and manual testing, ensuring the high quality and reliability of the final product.

This IT project to develop an information system for class schedule management will enable higher education institutions to enhance the productivity of department staff and improve the quality of schedule creation. This, in turn, will lead to increased satisfaction among both teachers and students with the schedule, a reduced workload for the educational process participants, improved delivery of educational services, and better student performance, which, over time, will result in increased popularity of the educational institution.

6. Conclusions

The implementation of the IT project for developing the university class schedule management information system is quite a challenging task, with each development stage requiring the highest quality implementation to ensure that the information system meets the specified characteristics, namely: speed, reliability, security, expandability, and adaptation to a specific higher education institution.

The article examines the IT project of a university class schedule management information system. The proposed concept demonstrates a number of advantages compared to similar products, in particular, the integration of a schedule generation mechanism based on teachers' preferences and artificial intelligence algorithms. The approach to designing such systems has been studied, and the main functions of the system are also discussed. Various aspects of the system design have been investigated, such as the functioning of the algorithm for analysing class schedule conflicts, the creation of new users within the system, and the possibility for students to view information.

The developed IT project, which uses modern technological solutions and methodological approaches, demonstrates a high level of stability, performance, security, usability, and modularity. The database design and business process modelling of the information system using UML diagrams visually represent the system architecture, component interaction, and data flows between different

modules. This confirms the effectiveness of the selected technologies and methodologies for creating a reliable and functional information system.

Thus, it should be noted that developing information systems for managing class schedules requires a sufficiently deep knowledge of the relevant technologies to ensure compliance with the requirements. Systems that use appropriate algorithms and artificial intelligence will significantly simplify the process of creating timetables and have a positive impact on their quality. As a result, employees of university departments will be able to create better timetables, which will lead to increased user satisfaction with the timetable, improved provision of educational services, and reduced workload for participants in the educational process.

Declaration on Generative AI

The author(s) have not employed any Generative AI tools.

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