Information System for the Formation of Individual Educational Trajectories of Students of IT Specialties

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Abstract

Today the educational environment and methods of its interaction with people are rapidly developing. Everyone has the right to education and choice. The concept of individual educational trajectory, its features and problems of formation are described.

The individual educational trajectory will allow students to make their own choice among the proposed disciplines, therefore, to choose their own path to realize the potential.

Also, the problem of forming an individual educational trajectory by the method of information system is also considered. Recommendation systems were considered as an example of the implementation of an information system for the formation of an individual educational trajectory. Prototype of the recommendation system was also described and developed.

Keywords [1]

Educational trajectory, curriculum, educational program, academic mobility, recommendation system, prototype, discipline, student.

1. Introduction

Modern education today is developing at a very impressive, often unpredictable pace with the priority goal in the development of competent professionals. Necessary qualities of such specialists are the ability to self-development and self-realization. Providing educational services to everyone, taking into account their capabilities, preferences and abilities, will ensure the dismissal of such specialists. Thus, adhering to the idea of accessibility and equality of education, there is a possibility of introducing individual educational trajectories. Providing the opportunity to choose an educational trajectory will create conditions for the realization of the potential of each student or applicant and will avoid situations where education becomes undesirable or meaningless.

In this regard, the focus of the educational process on students becomes especially relevant, which includes: taking into account individual capabilities; needs of the entrant; ensuring their freedom; incentives to determine the individual content of educational activities and conscious and responsible choice of individual educational trajectory. Thus, in our reality, every student can hope to get a quality education and choose an individual educational trajectory.

[1]Proceedings of the 2nd International Workshop IT Project Management (ITPM 2021), February 16-18, 2021, Slavsko, Lviv region, Ukraine

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1.1. Problem overview

Modern social realities are characterized by significant changes in social and political life, rapid technical and technological development. This contributes to the formation of the information society, the widespread use of information flows, which are the inexhaustible and renewable wealth of mankind, along with energy and material resources. An important feature of the modern information society is informatization, which in the form of practical activities, certain activities and technologies aimed at the use, storage, processing of information, as well as its transfer to achieve the goals of society. An important area of informatization of society is the informatization of education, which allows to increase the efficiency of all types of educational activities through the use of information and computer technology.

Among the variety of tools that ensure the implementation of differentiated learning, a significant role belongs to individual educational trajectories. At the same time, there is a lack of electronic resources, in particular information systems, which would allow to form an individual educational trajectory of entrants based on their wishes, educational and psychological capabilities.

However, given the wide range of information and communication technologies, it is possible to create an information system that will shape the individual educational trajectory of future students of higher education institutions based on the choice of disciplines in the block of disciplines of free choice of students. Such a system should also provide access for registered higher education students to information on subjects contained in the curricula of the specialty.

Before creating a prototype of an information system, it is necessary to consider existing implementation options. In particular, there are many online information systems that provide services when choosing an educational institution and future profession. However, not all of these resources can provide recommendations for the formation of an individual educational trajectory. Most online resources provide general information without taking into account the individual qualities or characteristics of the applicant.

For a detailed analysis of the existing systems of choice and recommendations of the educational institution, a functional analysis of both foreign and domestic online resources was performed. This analysis is shown in Table 1 with key parameters.

H1 - definition of the professional orientation of the person;

H2 - taking into account personal qualities and abilities;

H3 - recommendations for choosing an educational institution;

H4 - the formation of an individual academic trajectory.

Table 1

Online resources of educational choice

Name	H1	H2	H3	H4
TopUniversities	+	-	+	-
Postupi online	+	+	+/-	+/-
MyPath101	+	-	+	-
SchoolSearch	-	+	+	-
The Good Universities Guide	+/-	-	+	+/-
AcceptU	+	-	+	-
Moe obrazovanie	+/-	+	+	+/-
Infopraca	+	+	+	-
Uni Finder	-	-	+	-
Hobsons	+	+	+	+/-
Education.ua	-	-	+	-
BigFuture	+	-	+	+/-
Adventures in Education	-	+	+	+/-

As a result of the functional analysis, it can be concluded that the existing online information resources focus more on the choice and recommendations of educational institutions, regardless of the personal qualities or professional skills of applicants.

1.2. Analysis of recent research and publications

Various aspects of the introduction of information and communication technologies in the educational process are constantly attracting the attention of many researchers. Didactic-pedagogical and methodological problems of informatization of separate educational trajectories in the educational process were studied by E. Alexandrova [1], I. Vakarchuk [2], I. Kankovsky [3], S. Kliminska [4], O. Plaksinova [5], I Lipatnikov [6] and others. Studies of P. Fedoruk and M. Pikulyak [7], Stroganova AN, Korostiants TP, Sharova SV and other scholars are also devoted to the study of this issue.

In particular, E. Alexandrova interprets the individual educational trajectory as a personal way of realizing the personal potential of students. In addition, this concept means a program of formation and development of life, in particular personal, for a certain period of time [1, p. 75].

According to I. Vakarchuk, the use of the principle of individual trajectory of the student will bring the educational process of our country closer to the principles of higher education in Western Europe [2].

This statement is justified, because the possibility of free choice within the chosen specialty - one of the conditions for stability and coherence of any educational system.

Given that the individual educational trajectory is also a fairly general concept than an individual educational route, I. Kankovsky understands this concept as a movement chosen by the student in accordance with the individual educational route to achieve a certain level of professional competence defined by the standard of education. and own desire. At the same time, the individual educational route can be presented in the form of an individual program of student professional competence formation taking into account one's own interests, educational opportunities, psychological characteristics, etc. [3, p. 63].

According to S. Kliminska, the individual pace and volume of educational work intensify the student's cognitive activity, improve his abstract and analytical activities, motivate active creative work. This contributes not only to the implementation of the individual educational trajectory, but also allows to form the professional personality of the future specialist [4].

According to O. Plaksina, understanding the need to choose specific variable modules arises in students gradually, in the process of their maturation, their development of basic modules, immersion in a professionally-oriented educational environment [5, p. 149].

I. Lipatnikova proposes to use a reflexive approach to ensure the quality of the mechanism of designing an individual educational trajectory. In her opinion, such an approach is a system-forming factor and a universal mechanism for managing the educational process on the basis of jointly distributed activities of teachers and students. At the same time there is a process of search, comprehension and rethinking of the information, its transformation by the independent choice of the micro goals taking into account individual abilities and needs; determining the trajectory of development of personal qualities of the student [6, p. 108]. P. Fedoruk and M. Pikulyak built a model of individual learning trajectory based on the method of multilevel algorithmic quanta of knowledge, which has the following form: based on the results of the first task (the first vertex of the graph characterized by its terminal quanta) the student gets to another vertex also characterized by the corresponding quanta, and so on. The authors of the model note that the proposed method allows to automate the process of content of the discipline and reduces the time for its study [7, p. 75].

Researchers reasonably argue that the individual pace and volume of educational work activates the student's cognitive activity, improves his abstract-analytical activity and motivates him to active creative work. This contributes not only to the implementation of individual educational trajectory, but also allows you to form a professional personality of the future specialist. A number of researchers suggest the use of information technology and information systems to support the processes of forming an individual learning trajectory, as this would bring the educational process closer to the student-oriented principles of higher education in the world.

In the works of Natalia Kunanets it is noted that information technologies play an increasingly important role in everyday life: from providing information on the weather forecast, to the possibilities of virtual movement. Huge amounts of data in the fields of science, professional, educational and entertainment are processed every second. The selection and processing of large amounts of data is carried out using numerous routine processes that require new innovative technological solutions, data analysis methods and meticulous study. To perform such tasks, it is advisable to use methods of big data processing.

In the process of selecting information, there are opportunities to analyze the characteristics of an individual, which, in turn, generates the formation of systems and tuples of new parameters, which are subject to further analysis. In particular, it is about measuring knowledge potentials, the level of interest in certain areas, wishes for future study of certain disciplines, behavioral characteristics, analysis of impressions and emotions, the psychological state of the person. The implementation of such an approach would focus in educational processes not only on the level of success, but also on the personal characteristics of the student as a member of the educational society, which allows to determine the degree of adaptability to cooperation, which, in turn, can play a significant role in forming effective social relations. rather than exceptionally deep knowledge in a particular field. If a person does not find an understanding with the employer, co-worker, or subordinates, the process of integration into the new social environment may be ineffective and may eventually lead to a complete fiasco [8].

To compare domestic and foreign research, it is worth referring to the work of Aaron M. Pallas. As indicated in his work, life course studies originating in the United States have paid relatively little attention to the challenges of describing educational trajectories. In the United States, an individual's position in the education system is reasonably well described by the number of years of schooling completed. It is certainly convenient to be able to summarize an individual's standing in a single number. But this vertical differentiation of educational statuses is not an adequate representation of the educational systems of a great many countries around the world. Even in the United States, the number of years of schooling completed does not convey precisely the educational credentials an individual has acquired. Fourteen years of schooling can, for example, represent successful completion of a 2-year technical college degree program, or 2 years of liberal arts coursework that falls short of any credential. Other educational systems rely more upon the horizontal differentiation of individuals into differing types of educational institutions, or into differing locations within the same institutions, than upon the number of years of schooling completed.

Only recently has a concerted effort been made to develop a classification system for educational attainment that might facilitate comparisons across countries and time periods. This project was entitled "Comparative Analysis of Social Mobility in Industrial Nations" (CASMIN). The classification system, known as the CASMIN classification after the project title, is based on two primary criteria: (1) a hierarchy of educational levels, defined in terms of the length of the educational experience, its cost and quality, and the academic ability required to be successful, and (2) a distinction between "general" and "vocationally-oriented" educational experiences. This latter distinction is based on curricular intent rather than empirical linkages between educational qualifications and specific vocational outcomes. That is, the central distinction is between educational programs that are intended to teach the knowledge and skills needed for specific occupations and those intending to teach general knowledge. Comparative research inevitably involves tradeoffs between the commonalities and uniquenesses of the cases under consideration. Classification schemes such as the CASMIN classification are intended to balance such tradeoffs. Nevertheless, the same classification that facilitates comparisons across countries can seriously distort comparisons within countries. Applicability of the The CASMIN classification of the United States was analyzed. It shows that within the United States and other countries, the relationship between educational qualifications and occupational attainment is generally greater if the analyst uses indigenous qualifications—that is, qualifications that are recognized locally—than if the association is estimated with classification schemes such as CASMIN developed for comparative purposes. Thus, although the CASMIN classification is useful for some purposes, it presents difficulties when an analyst wishes to study the link between educational qualifications and occupational attainment [9].

The article's goal is to analyze the functionality of the information system, such as a recommendation system for the formation of individual learning trajectories of students of IT specialties, based on their wishes, abilities, educational and psychological capabilities.

2. Research methods

The process of forming an individual educational trajectory is a rather complex procedure, which involves the analysis of the curriculum of the specialty, acquaintance with the annotations of disciplines included in the curriculum, analysis of competencies formed in the study of specific disciplines.

The individual educational trajectory itself is understood as a personal way of realizing the personal potential of the learner, which is formed taking into account his abilities, interests, needs, motivation, opportunities and experience. It is based on the choice of the student: types, forms and pace of education, subjects of educational activities and their proposed educational programs, disciplines and the level of their complexity, methods and means of teaching. Individual educational trajectory can be implemented through an individual curriculum [10] and academic mobility programs.

Under the individual curriculum means a document that determines the sequence, form and pace of learning the educational components of the educational program in order to implement its individual educational trajectory and is developed by the educational institution in cooperation with the student with the necessary resources [10–20]. The individual curriculum indicates the disciplines that the student chooses in accordance with the approved curriculum standards for study in the next academic year.

The academic mobility program provides a clear definition of the types and forms of academic mobility; consolidation of the principle of re-crediting the received grades in certain subjects on the basis of the European credit transfer system, in particular, by comparing the content of educational programs, without taking into account the names of courses; preservation of the place of study and scholarships for students participating in academic mobility programs [21–32].

Individual educational trajectory also requires special organization. For example, individual educational trajectories are developed for the student taking into account features of the educational program.

Educational (educational-professional, educational-scientific or educational-creative) program - a system of educational components licensed at a certain level of higher education within the specialty, which determines the requirements for the competencies of persons who can start studying under this program, a list of disciplines and logic the sequence of their study, the number of credits of the European credit transfer and accumulation system required for the implementation of this program, as well as the expected learning outcomes (competencies), which must be mastered by the applicant for the appropriate degree of higher education [10].

Thus, the formation of an effective individual educational trajectory requires a powerful tool for implementation, as well as special methods and technologies. Accordingly, for effective implementation it is necessary to implement an information system. As a special case, we have chosen the system of recommendations that is the most appropriate and effective. A recommendation system is a subclass of an information filtering system that creates a ranking list of objects that a user may prefer. In the process, recommendation systems collect user data using a combination of explicit and implicit methods. These methods are described below.

Methods of explicit data collection:

- the user evaluates the proposed object on a differentiated scale;
- the user classifies a group of objects from best to worst;
- the user chooses the best of the two proposed objects;
- the user is prompted to create a list of his favorite objects.

Methods of implicit data collection:

- observation of information that the user browses in online stores or databases of other types;
- keeping records of user behavior on the Internet;

- tracking the content of the user's account on social networks.

Implementation of the project of creating a prototype of a recommendation system for the formation of individual trajectories in order to form individual trajectories of the applicant. The work of the recommendation system consist of four stages (Fig. 1):

Stage 1. Conduct an analysis of educational institutions, as this will allow us to collect data on new educational and professional programs licensed by them.

Stage 2. On the basis of the chosen preferences and the list of disciplines available in educational and professional programs - the first recommendations are created.

Stage 3. Selection of the most acceptable educational institution, specialty and educational-professional programs. This process takes into account all previous raw recommendations and compares them both with the potential of the applicant's knowledge and with the relevant data of educational institutions. It also generates a list of subjects for external evaluation.

Stage 4. After successful entry, there is the formation of an individual educational trajectory for the student.

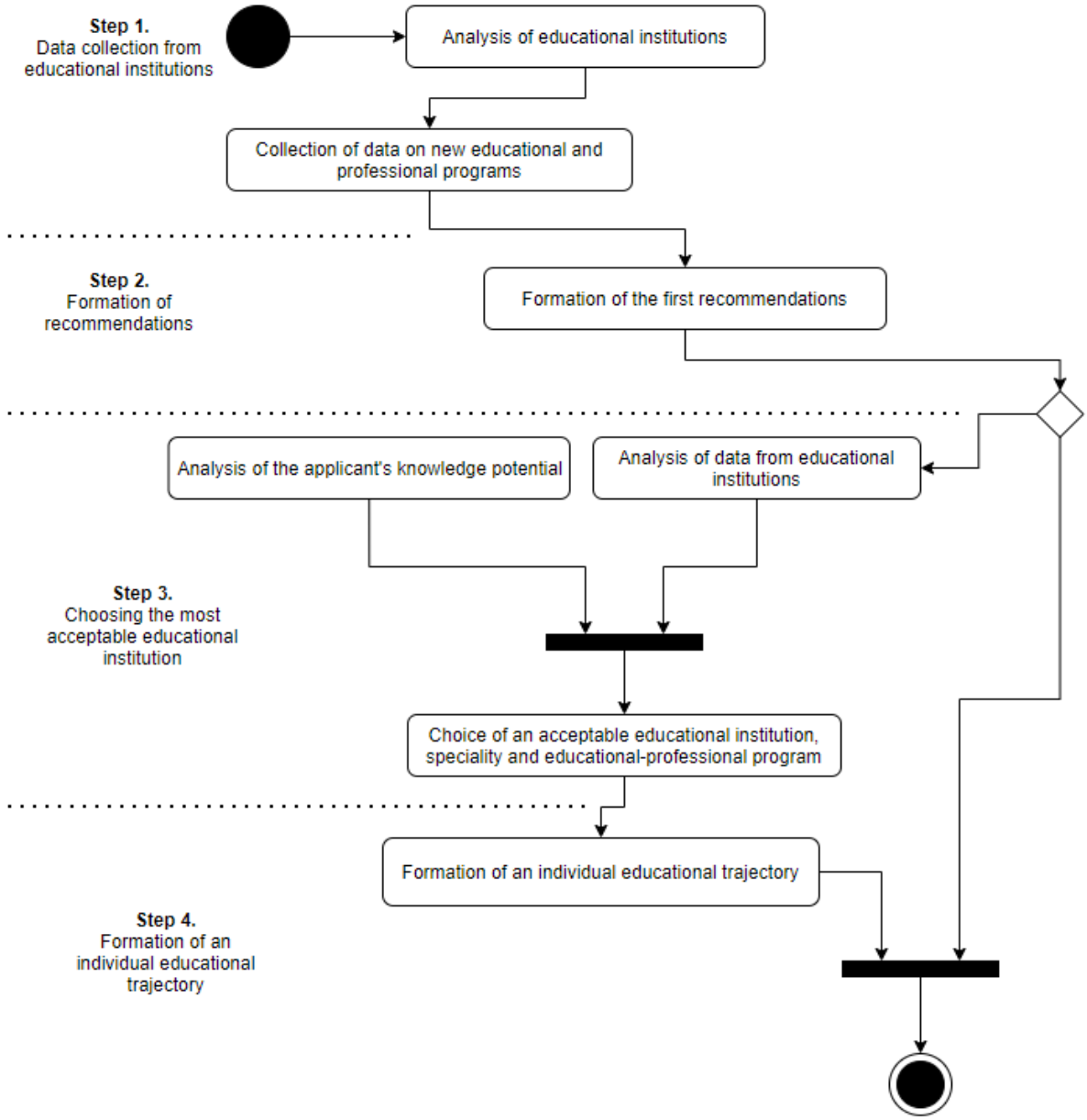

Figure 1:"Activity chart" of the recommendation system.

2.1. Data analysis of an individual educational program

To build an individual educational trajectory, it is necessary to create an individual educational program, which is its technological support. Accordingly, the means of embodiment is the technology of its design. Within the framework of the recommendation system, the formation of an individual educational program is a process that consists of the following steps (Fig. 2):

Step 1. Look for an educational institution that can provide the best knowledge in the desired specialty or educational-professional program and collect all the data from the disciplines included in them.

Step 2. Analyze the individual needs of the student and include them as a major factor in determining the disciplines

Step 3. Analyze the disciplines that best match the competencies required by the student and pre-process the data, especially for structuring and unifying, disassembling and processing incompleteness.

Step 4. To form a list of disciplines based on the characteristics of the educational institution, educational and professional program and individual needs, which is an individual educational trajectory.

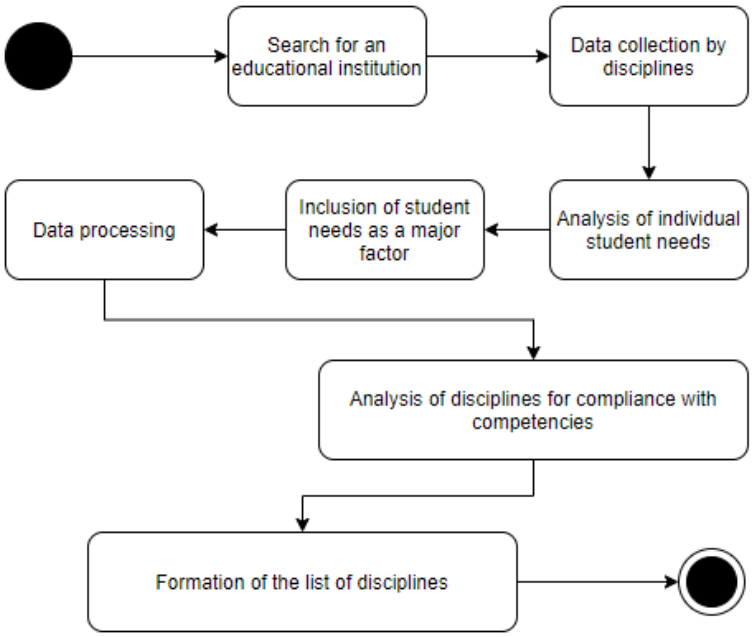

Figure 2: "Activity diagram" of the process of forming an individual educational trajectory of the student.

Once the model of the recommendation system is ready and implemented, in particular as a web tool, users will be able to access it. The algorithm of the system is shown in Fig. 3.

At the first step, the user enters the name of the specialty he wants to get acquainted with. According to the chosen specialty, the next step is to form a list of acceptable educational institutions. After these two steps, the system will show the user the results and ask if they are acceptable to him. If so, the system will continue, if not, the user will receive an offer to such an institution.

First, their results are tested and analyzed for vocational guidance, which are then used as the main factor in the next step. Then there is the choice of educational institution and specialty. Based on these data, the formation of an individual educational trajectory takes place.

2.2. The results

Based on the above methods and models, a plan of the recommendation system for the formation of individual learning trajectories was developed. The structural model of this system includes: a

subsystem for finding a suitable educational institution, a subsystem for determining professional orientation, a subsystem for determining the list of disciplines for an educational program, a subsystem of formation an individual educational trajectory. The structural model with all subsystems is shown in Figure 4.

The recommendation system is planned as a single-page application, the architecture will be developed on the basis of client-server technology, which will allow working in both local and network modes.

The recommendation system will work in the following steps:

Step 1: System launching.

Step 2: User identification; authorization check.

Step 3: User data entry.

Step 4: Request to educational institutions; search for a suitable institution.

Step 5: Checking the compliance of the educational institution; choice of educational institution.

Step 6: Passing the test for professional orientation.

Step 7: Analysis of results.

Step 8: Obtaining a recommended list of educational institutions and specialties.

The user interface is currently unavailable and is under development. For further development of the user interface it is planned to use HTML markup language along with cascading tables of CSS stylesheets. Dynamic functionality will be implemented with the use of JavaScript and third-party libraries.

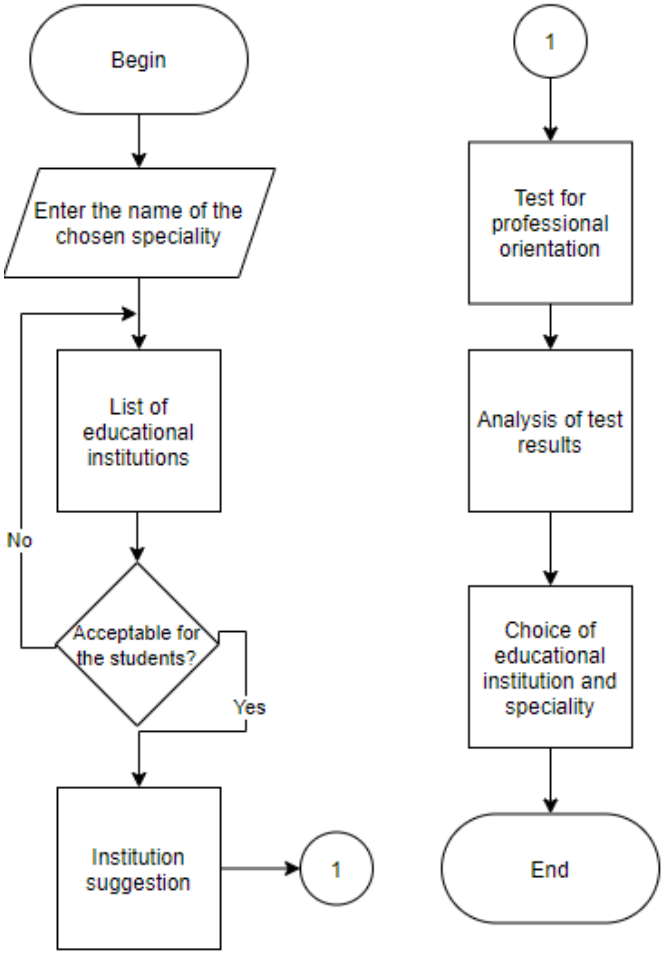

Figure 3: Algorithm for selecting an individual educational trajectory.

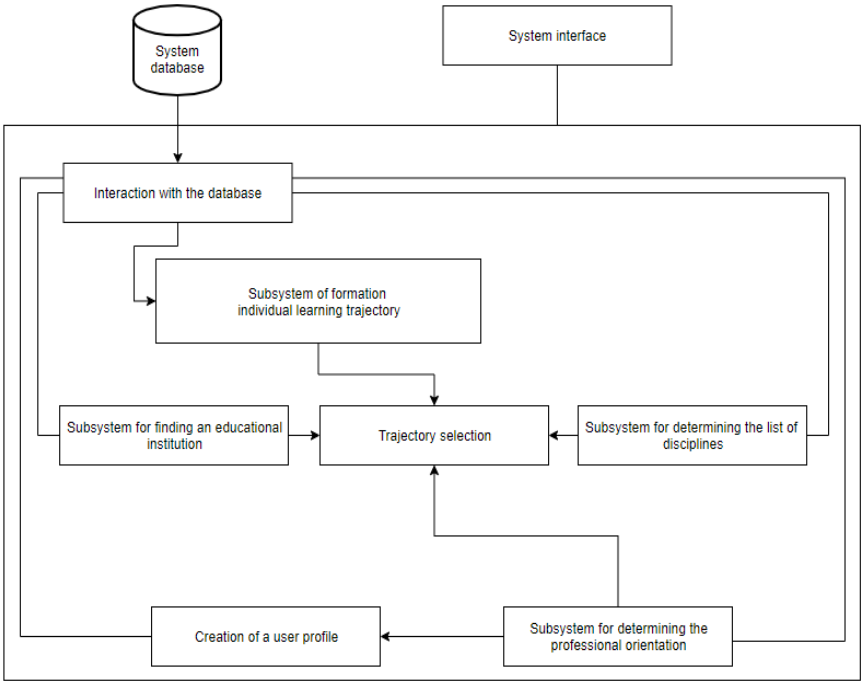

Figure 4: Structural model of the recommendation system

Figure 5 shows the way of functioning for the recommendation system.

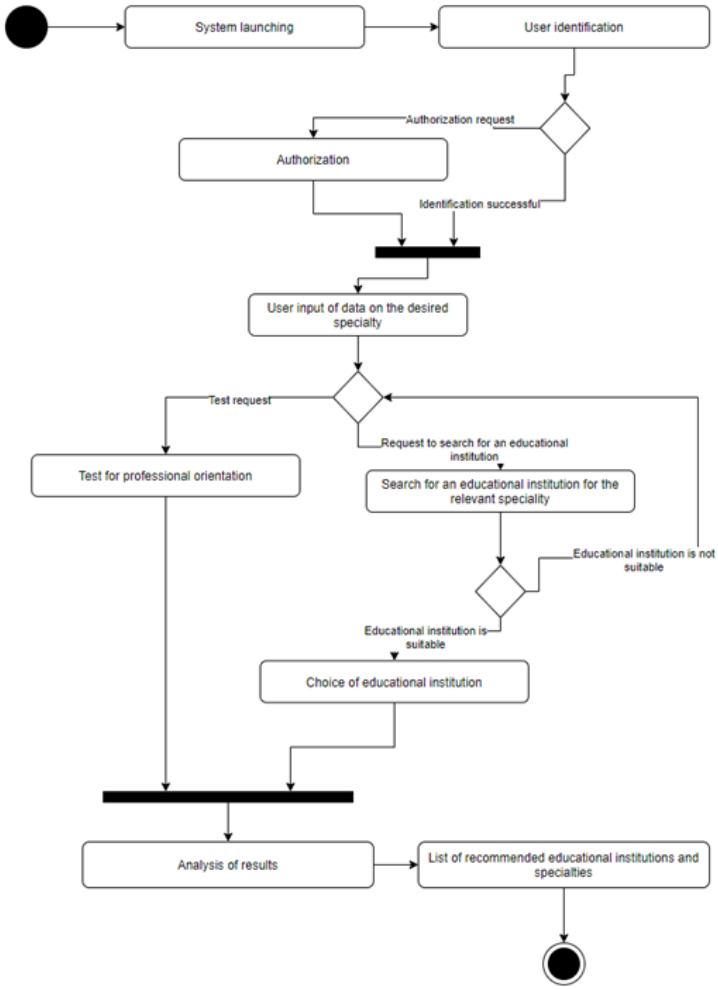

Figure 5: Scheme of functioning of the recommendation system

3. Conclusion and prospects for further research

The process of forming an individual educational trajectory is a rather complex procedure, which involves the implementation of a project to build a recommendation system. The functionality of the recommendation system tests the entrant, analyzes the possibilities of the university, specialties, educational and professional programs, their curriculum, acquaintance with the annotations of disciplines included in the curriculum, analysis of competencies formed in the study of specific disciplines. The use of a recommendation system for the formation of an individual educational trajectory increases the efficiency of the procedure of building an individual educational trajectory through a system of recommendations.

The prototype of the proposed recommendation system can be implemented as a web tool for use by applicants looking for a way to form their own individual educational trajectory.

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