

Student Web Portfolio Information Technology

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Abstract. The search and recruitment of young IT-specialists, even students, can be improved by using information technology that would provide relevant information on the level of candidates' skills. Creating such technology that contains electronic portfolios of student achievement validated by their teachers is an actual need not only for employers. Students are also interested in using such a portfolio to present their professional achievements, as well as to get information about current needs of the technology market. Teachers of educational institutions can use such information technology to maintain competition and motivate students. Such technology should enable quick search and display of information on students' professional skills. While desining such technology, we should take into account needs of all kinds of users, i.e. IT-students, teachers, and employers. Using such technology, students should be able to create a portfolio which describes their knowledge and skills, the task of teachers is to verify the accuracy of the information, and employers use this system to find the specialists they need. The implementation of such technology using the website provides ease of use and easy access from any device that has access to the Internet. Such technology should also enable adding new types of skills because the number of new technologies is steadily increasing. The information technology of students' web-portfolio should provide an intellectual search to enable relevant results both for IT-students and employers.

Keywords. Web-portfolio, electronic portfolio, e-portfolio, information technology.

INTRODUCTION

The information technology industry is a young, fast-paced industry, with the results of its activities spanning an ever-larger part of daily life. Its rapid development creates a constant need for skilled personnel. As a result, more and more young professionals and even students are being hired. One of the disadvantages of hiring young professionals is the lack of previous experience in real IT projects. When hiring a young specialist, the employer is forced to take on certain risks, such as the inability of the candidate to perform the job after the probation, the candidate may find a job at another company, after all, the company does not have any relevant data about candidate's knowledge and, accordingly, such employee might not be able to work out the expenses of the company for its preparation.

On the other hand, students who are planning to look for a job in IT are also, to some extent, in an uncertain situation. In spite of the knowledge of various modern technologies, learned in the educational institution, self-education is a rather effective way to obtain the knowledge and skills required by IT companies. Students need to have information on the current hard and soft skills required in the IT field. Unfortunately, for IT students in Ukraine, there is no source of such information.

So, it is necessary to create an information technology, which will manage an electronic student portfolio. Such technology would facilitate interaction between employers in the IT industry and students as potential employees. Such technology will be useful for employers if it contains validated information about students' hard skills. Such technology will have value for students as it will allow monitoring of what technologies are of high demand between IT-employers. Teaching staff can use it as a tool for indirect cooperation and an indicator of trends in information technology development.

To design such information technology, we shall analyse existing technologies that enable keeping a records of the professional skills, we shall explore their advantages and disadvantages, establishing the main functions that such technology will have. The next stage is to develop models and set the requirements for the designed information technology. We shall also present an algorithm of students' web-portfolio verification and valuation.

The subject of the study is the process of keeping a record of students' professional skills, as well as the process of displaying the information sought, based on the input of the user and statistics of his previews.

STATE OF ART

An electronic portfolio (e-portfolio, web portfolio) of a student is a collection of electronic evidence collected and managed by him. Such electronic evidence may include text, electronic files, images, multimedia, blog entries, and hyperlinks.

Researchers consider e-portfolio as [1]:

- a tool of formation of professional skills;
- a portfolio of achievements;

- a means of improving the quality of education and individual student progress;
- a technology of monitoring and evaluating learning achievement as part of the learning process.

Electronic portfolios are used in many areas, for example, in foreign language education [2, 3], as a tool for teaching students to assess students' knowledge [4-8], as a tool for improving the quality of learning and enhancing student motivation [9-13], in social media [14], in medical institutions [15].

In [16], the author describes the portfolio as a tool for motivating learning and improving the student's knowledge quality using the e-portfolio technology developed by the Center for Distance Learning Education. Authors in [17] focus on the creation of models and templates for e-portfolios as an authentic assessment tool within the European Higher Education Area.

Electronic student portfolios are increasingly used in other disciplines such as communication, mathematics, business, IT, engineering and architecture [18].

ANALYSIS OF SIMILAR PROJECTS

LinkedIn is one of the information technologies that can fulfill some of the required functions of a student's web portfolio. *LinkedIn* is a social network that brings together professionals from all over the world, enabling career opportunities. The network is popular and has over 200 million users from 200 countries, representing around 150 industries. This platform is aimed to increase the number of professional contacts, as well as creating initial business relationships with new people. In the profile of such a network, the user specifies information about the education, knowledge and hard skills they have. This resource is aimed primarily at professionals who already have some experience in a particular field and want to expand their capabilities. The use of such technology loses its attractiveness to students due to lack of work experience, and potential employers are not able to obtain additional information from their previous workplace. The student, of course, can add his skills, but this information will not be confirmed, so it may not cause interest from employers.

Various job search sites also have certain features of the web portfolio. An employer can search for employees using filters or announcing vacancies on the website. Before posting vacancies, one should register a company in the database of the site, so that everyone could see the full list of vacancies of a particular company and choose the one that most appeals to them. The disadvantages of such systems include the orientation of such a site, first of all, to professionals with experience, as well as the lack of means to check the accuracy of the information, the availability of unreliable, outdated data.

Resources like *portfoliobox.net*, *crevado.com*, *squarespace.com*, etc. can create e-portfolios with static images, but they have no job search function. Therefore, such a resource can only be used as an addition. These resources, as tools for creating e-portfolios for students in the IT industry, have obvious drawbacks. For example, most hard IT skills can not be displayed graphically, so using the above technologies seems inappropriate.

Thus, the above-mentioned information technologies, which could be used as a web portfolio, have disadvantages, almost all resources are focused primarily on professionals with experience, most technologies have no mechanisms to verify the reliability of information; information can be duplicated, outdated, etc. That is why there is an actual need to create an information technology to improve the keeping a record of a student's professional skills to motivate him and present his achievements, and so that these achievements were accessible for employers, who consider hiring students.

MAIN IDEAS AND METHODS

The designed technology of the student's web portfolio aims to simplify the process of finding the first job for students in the field of IT. Such technology should store data on the student's hard and soft skills, ensure the accuracy of this data, provide quick and convenient access to select and view the information required for interested parties, namely employers, students, and teachers. To verify the accuracy information, provided in student's portfolio, it is necessary to involve teachers, since it is the teachers who are aware of the student's level of knowledge, this group of users is a guarantor of the reliability of the information.

The information technology Student's web portfolio should enable:

- the ability to create an account of different types of users, at least for the student, employer, and teacher;
- the ability to create and edit a portfolio of students;
- the ability to create and edit jobs by employers;
- the ability to verify student's information by teachers;
- the ability to filter data when searching portfolios and jobs;
- an intelligent search;
- possibility of system maintenance.

INFORMATION TECHNOLOGY FUNCTIONS AND REQUIREMENTS

For the correct implementation of the product, it is necessary to clearly describe the set of requirements for the created system. For better perception of the requirements, it is necessary to structure these requirements and divide them into specific groups.

FEATURES OF THE REGISTRATION AND AUTHORIZATION PROCESS

Creating a new account, that is, registering, as well as an authorization mechanism, are the basic and one of the most important mechanisms for information protection. These mechanisms are responsible for identifying the user and providing functionality depending on his rights.

The registration mechanism must meet the following requirements:

- check for the existing of the user with identical e-mail;
- require the user to create a complex password using numbers and special characters;
- check that all required fields are completed.

Requirements for the authorization mechanism are:

- in case of incorrect data input, return an error message to the user;
- in case of successful authorization, give access to the functionality according to the rights of the user group.

FEATURES OF THE PROCESS OF CREATING AND EDITING A PORTFOLIO

The portfolio creation page should include the following options:

- references to open repositories, if any;
- provide a list of hard skills so that the student can choose the relevant one;
- field for additional information about the student.

In order to keep the information up to date, all these fields must be editable. If there is currently no new technology, the system should allow the user to add the appropriate skills.

Viewing an information means having access to profile list and job list. When selecting a particular profile, a user profile should be opened, indicating the student's skills list and general information about him/her. The list of user skills will be displayed in a table, each skill should contain all the necessary

information, such as the name of the skill, the credibility of the skill and the date of the test. If the user's skill has been verified, information about the user who tested it must be displayed. If any skills are untested, a button to confirm the validity of the data should be displayed for the data validation user.

There should be an ability to verify information, provided by students. Information validation rights should only be available to teachers. Also, the duties of the teacher include checking the authenticity of persons.

The mechanism for creating and validating new skills and technologies should give any user the ability to add new skills so that they can then be tested by authorized users and possibly displayed in the main list of skills in the system.

The user authentication technology should enable the system to work autonomously without the need for an administrator. An administrator is only required if some incorrect data is to be corrected, individual users are to be locked or deleted, or data is to be edited that cannot be altered otherwise.

FEATURES OF THE PROCESS PORTFOLIOS AND VACANCIES SEARCH

The search engine should deliver the most relevant portfolios and jobs using smart search. To do this, a record of portfolio and job views and system searches must be kept, and the results should be displayed using this information. Whenever a user searches for data in the system, it is necessary to update the search statistics by adding the search filter data that the user has used to the statistics. As navigate through the portfolio or job search, in addition to displaying data, it will be requested to update browsing statistics, and a unique identifier links the selected search result to the completed search query, which helps you further fine-tune your sorting options.

The statistics are stored in a standardized format in a database. As the user attempts to search for information, the statistics are aggregated and ed in the server's memory for faster processing of information. The search query classifies the query and determines whether it is a modification of the previous query or a new query. It checks for cache search filters and calculates the number of parameters that have been changed in the search filters. If the number of changed parameters exceeds 30%, such a request is classified as new. Such classification makes it possible to recognize different types of queries, which in turn makes each series of queries specialized and in the future will ensure the uniqueness of queries, uniqueness in the statistics of search queries. Fig. 1 shows a search process using statistics:

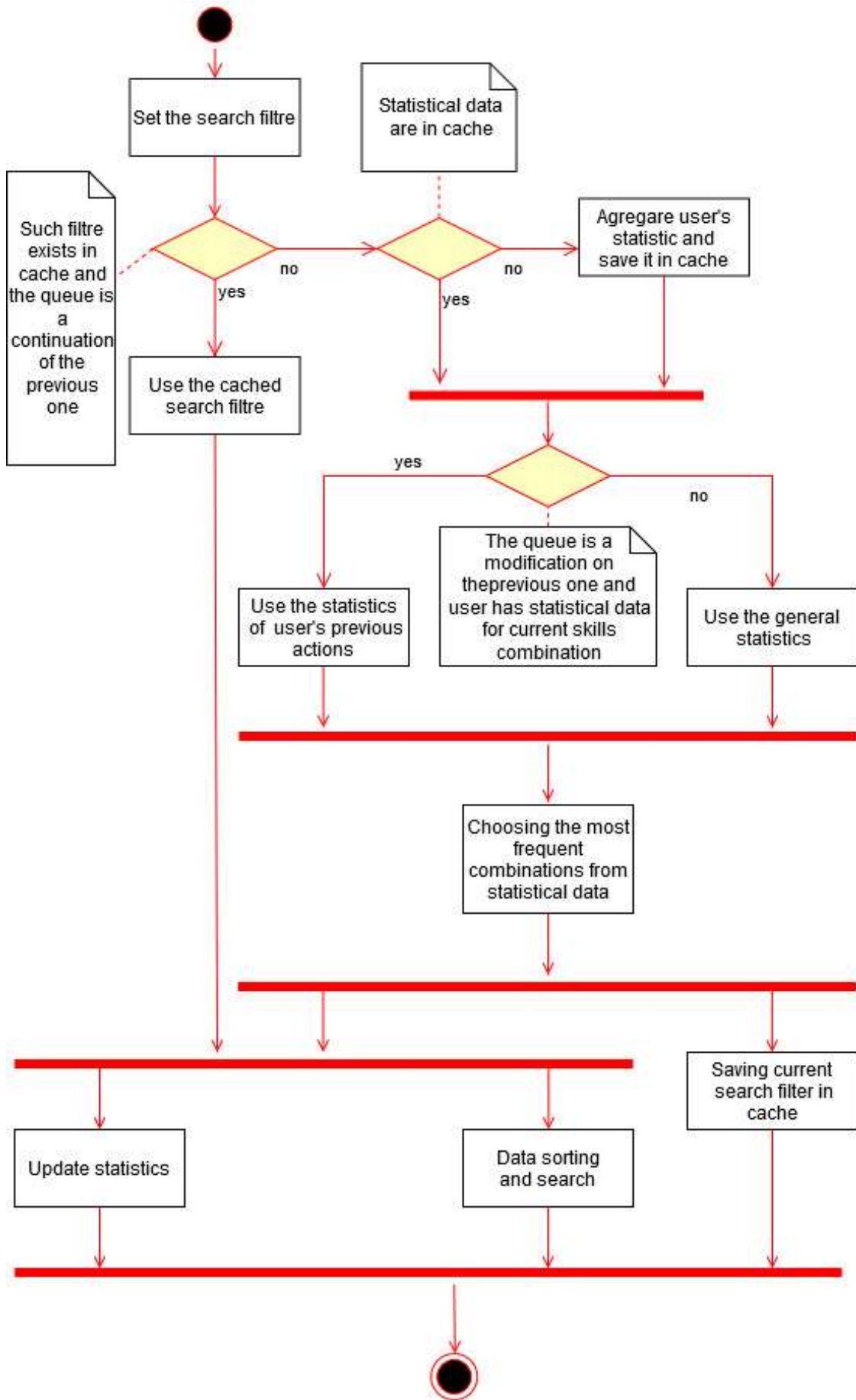


Fig. 1. Diagram the search process using statistics

DESCRIPTION OF THE LOGICAL STRUCTURE

At the stage of system architecture design, it is necessary to consider current requirements to the system and set possibilities for adding new functionality in the future. For easy management of the development process, it is necessary to divide the project into separate components. The project will consist of several parts (Fig. 2):

- wwwroot – static files (images and libraries);
- Areas - contains isolated areas of code, as a rule, contains Controllers, Models, Views components that have standalone functionality;
- Common – common constants used throughout the project;
- Controllers – business logic execution, database queries, system change state;
- Data.Entities – system entities;
- Helpers – auxiliary mechanisms that make it easier to write other program components;
- Migrations – database migration code;
- Models – data models used to deliver and collect data from the graphic interface;
- Views – system's graphic interface code;
- Startup.cs – a file with basic system settings;
- appsettings.json – configuration file.

In this template, projects are divided into 3 components that are interconnected, namely: model, view, and controller. This template is used to separate the data (Model) from the user interface (View) so that changes to the user interface have as little impact on the data, and changes in the model could be performed without changes to the user interface.

The main modules of information technology are *Admin*, *Profile*, *Skill*, *Vacancy*.

The *Profile* module includes the implementation of viewing and editing a user profile, as well as creating and editing a student's portfolio.

Skill and *Vacancy* modules have procedures for viewing, creating, and editing information about skills and jobs. These modules enable the creation, editing, and viewing of relevant data. *Skill* is fully accessible only by certified teachers and employers. These users can view and validate new skills added by other site users. Only employers have full access to *Vacancy* module functionality. Only they can view, edit, and delete (if necessary) the list of jobs they have created. Also, these modules have a system search.

The *Admin* panel is designed as a separate module. It provides the ability to edit data that cannot be replaced otherwise. An administrator can block and delete users, delete portfolios and jobs, and view all information on the site.

The diagram of classes (Fig. 3) of the *Vacancy* module is presented below.

The developed information technology performs the following independent functions: creation and updating of portfolios and vacancies, the search of portfolios and vacancies, support of the site, in particular, enables the possibility of adding new skills to the system. The process of creating and updating information is implicitly dependent on the procedure of adding new skills, as over time the list of technologies changes and without the ability to create new skills, the technology developed will quickly become out of date.

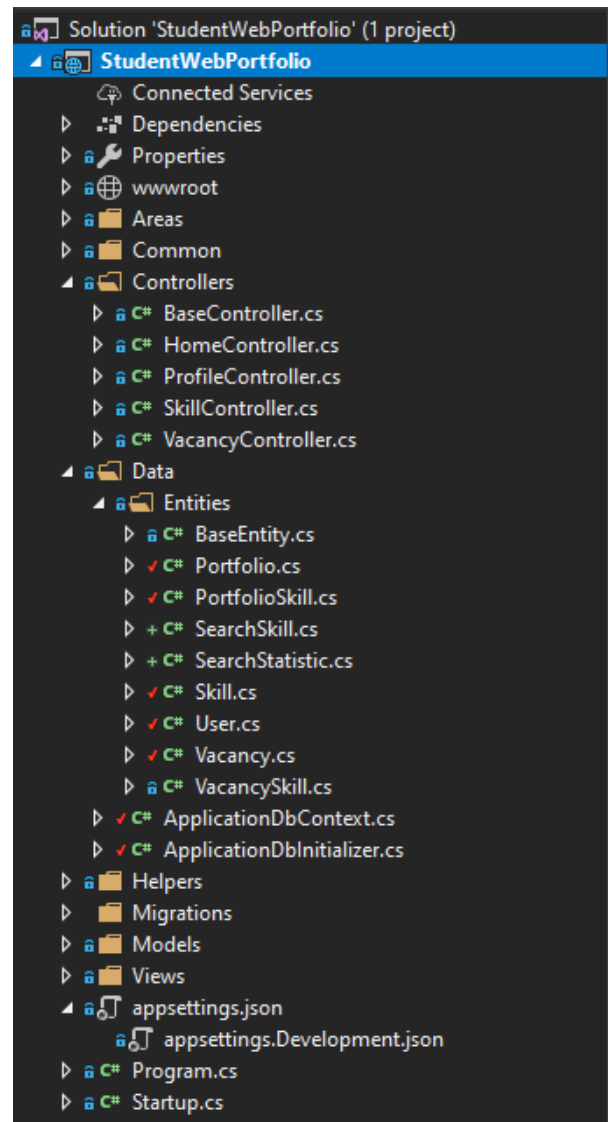


Fig. 2. Project structure

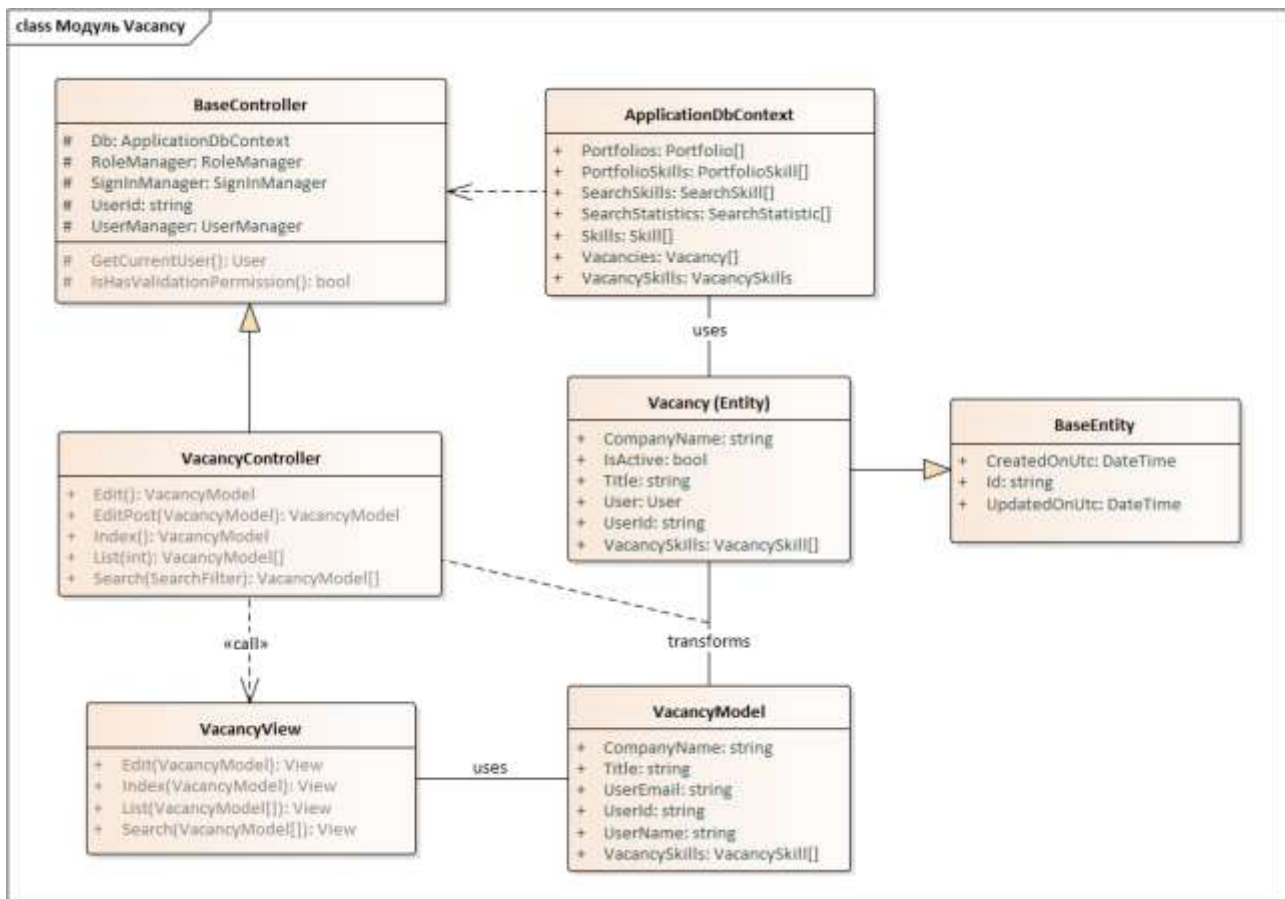


Fig. 3. Class diagram of *Vacancy* module

DATA STORAGE PECULIARITIES

MS SQL is used to accumulate data in the developed information technology. This DBMS has many advantages, including simplicity in the first installation, deep integration with projects on the .NET platform, the ability to view data through a graphical interface using Microsoft SQL Server Management Studio. A database schema was created that included 15 related tables. Tables starting with *AspNet* in their caption and *_EFMigrationHistory* tables are created automatically. These tables store user information and authorization and rights information on the system. *_EFMigrationHistory* stores information about changes to the database schema.

The *Portfolio* table is used to store student portfolio data. This table contains information about the student group, their level of English proficiency, links to public repositories, as well as the optional description field, in which the student may leave a brief description of himself/herself.

The *Skill* table contains information about a student's skills, that is, mastered technology, programming languages, and software.

The *PortfolioSkill* is a connective table, information in which reflects the relationship between student portfolio and skills. The *VacancySkill* and *SearchSkill* tables show the relationship between vacancies and skills and search statistics and skills that were used as filters. The *SearchStatistic* table stores statistics for portfolio and job searches. This table contains a unique ID, time stamp, user ID, and statistics type (portfolio or job). The data in this table is used by the intelligent search algorithm to improve information retrieval.

SELECTION AND JUSTIFICATION OF INFORMATION TECHNOLOGY CREATION TOOLS

To create an information technology with the specified functionality, a website, mobile application or PC application can be developed.

In our case, the advantages of the website usage are, among others, its low creation cost. Also, websites are accessible from almost any device, on any operating system. The main requirement is to have an installed browser and a working Internet connection. The cost of developing such information technology will be much cheaper than with other types of software since development occurs immediately for all platforms. One of the drawbacks of a website is its

poor performance, but this aspect should not be taken into account since today almost all gadgets have a large amount of computing power. We provide a laconic interface that will not cause a significant load on the devices used.

WEB APPLICATION STRUCTURE

The developed website has a typical structure, it includes registration and authorization functions, the ability to view and modify data. For a more productive, faster development process, we have used the *Bootstrap v4.1.3* style library, as well as the *jQuery v3.3.1* library and its add-on libraries. This set of libraries helps greatly increase the speed of development through ready-made methods and templates from which it is advisable to build additional functionality. Another positive feature of using these libraries is the ability to create websites that look good on both a desktop computer and a mobile device.

All the necessary links are in the navigation bar (Fig. 4, Fig. 5), which allows you to quickly and conveniently navigate the pages of the website. The list of links in the navigation pane changes according to the group of users and their rights.

The *Vacancies* link points to a job search page, and the *Portfolios* link points to a portfolio search page. In the *System* tab, the user can see a list of new types of skills that are waiting for confirmation before adding them to the main list of system skills. If the current user is a teacher, an additional *New users* link will also be available to one and will lead to a page with listed new users that are waiting for confirmation.

The e-mail tab links all the functionality needed to manage your own account, such as viewing and editing your own profile, changing your password, and more.

Another tab that is only available to employers, is *Vacancies*. This tab replaces the identical link and contains more functionality, namely a link that leads to the creation of a new job, that displays a list of jobs and a job search page from all over the site.

THE SERVER PART STRUCTURE

An important decision after choosing a programming language is to choose a framework for creating the server part of the site. Among the popular technologies are *ASP.Net MVC / Web API* and *ASP.Net Core MVC / Web API*. These technologies have many similarities, but there are also significant differences. The *Core* technologies have been recently developed, all the positive features of a previous technology were inherited, as well as some problems were solved. These technologies support the development and launch of more operating systems, making it very promising in the future. Comparing the *MVC* and *Web API*, it's worth saying that the *MVC*-based technologies are primarily designed to build simple websites and provide functionality for both server and client-side development. At the same time, the *Web API* allows only the server-side to be developed, however, it has more mechanisms for specialized development. Considering all the positive and negative aspects of this technology, a decision was made in favor of *ASP.Net Core MVC*.

The *.Net* platform applications have several *ORM (Object-relational mapping)* technologies for working with databases:

TABLE 1. OBJECT-RELATIONAL MAPPING TECHNOLOGIES

Entity Framework Core	Dapper	NHibernate
Supports multiple databases	Support almost all relational databases	Support for the most common databases
Very fast database query development	Very slow database query development	Moderate database query development
No need to know SQL instructions	You need to know the SQL instructions, as the developer needs to write queries to the database manually	No need to know SQL instructions
Low or medium performance depends on the developer's knowledge	Highest performance	Moderate performance
It is very simple for beginner developers, but it also has a large number of aspects for development in the future	Difficult to use, you need to independently develop an aspects for querying the database	It is relatively easy to use but has many procedures and techniques for learning

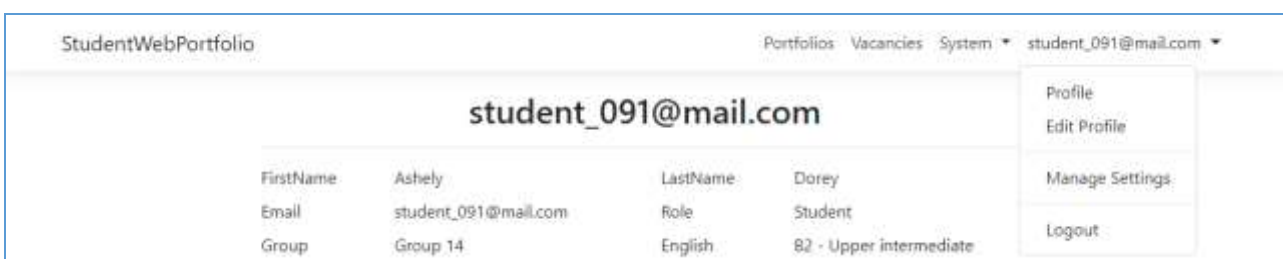


Fig. 4. Navigation bar (student)

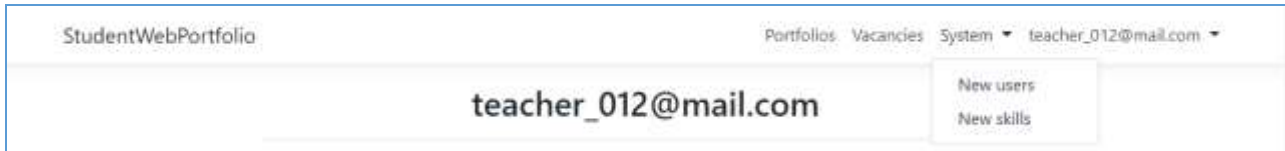


Fig. 5. Navigation bar (teacher)

Among the database technologies described above, the best solution is *Entity Framework Core*. This technology supports *MS SQL Database* and enables rapid product development. So, as a server, we will use software created on the basis of *ASP.Net Core MVC* framework. This technology works on the *MVC* (model – view – controller) model [19].

DEVELOPMENT ENVIRONMENT

Crucial characteristics of *Microsoft Visual Studio 2019* and *Rider* environments were compared for the project development (see Table 2).

TABLE 2. CHARACTERISTICS OF DEVELOPMENT ENVIRONMENTS

Microsoft Visual Studio 2019	Rider
Free version available	Paid versions of the environment only
The amount of functionality depends on the version selected, and for an additional fee, you can install additional extensions that greatly increase the functionality	There is a lot of functionality, but new versions of this environment always come out later than a competitor
It requires a lot of resources for its operation	Optimized, it has better a performance compared to its competitor

The above development environments are one of the best environments among many technologies. Considering the list of advantages and disadvantages of these programs, it was decided to choose *Visual Studio*, since this environment has a free version for system development.

The job search and portfolio search process is one of the most important components of the created information technology. Searching is done through filters, and search results are made more accurate by using a neural network. The search options are:

- *English level*, when the selected value is translated into a numeric variable (the higher the English proficiency, the greater the numerical value), and the search is performed among a portfolio with a given English proficiency level or higher. For example, if you select English level *Medium: B1 – Intermediate* – the search result will be all portfolios or vacancies with that English level and above;
- *Skill* is a list of skills that should be in the required portfolio. The search results will include all

portfolios or vacancies that have all the selected skills in their list of skills.

For better display of search results, a smart search engine has been added. Each search query and view of its user results is recorded in a history that allows you to generate statistics. Then, based on this data, the search engine calculates which skill combinations have the highest number of views and uses this information to sort the search results according to the most requested combinations of skills.

USER INSTRUCTION

The created information technology allows working for different groups of users: students, teachers, and employers. The instructions for using this system differ for each user group.

A feature common to all user groups is the registration process, managing your account, as well as searching for portfolios and jobs on the system. After logging in, the user will receive an email confirmation email and will be directed to their profile page after authorization. If the created user is a student, they will be asked to complete their portfolio.

The student must fill in all required fields. The completed portfolio is added to the search engine by checking *Make visible in the search system* tick.

On the user profile page one can see all the necessary information, ie. portfolio, job listing, as well as additional information (who validated the user, checked this portfolio, and more). At this point, the student user should contact the faculty to confirm the account on the website and the created account, to have full access to the functionality of the system.

On the portfolio (Fig. 6) and vacancies (Fig. 7) search pages users can search information according to their needs. For better search performance, one should use search filters. With smart search, in the first search results, the neural network displays portfolios or job openings that are of interest to the current user. Neural network decisions, first of all, are based on statistics of search and views of the user, and if it is a new user, then the general trend is the combination of filters collected from all users of the site.

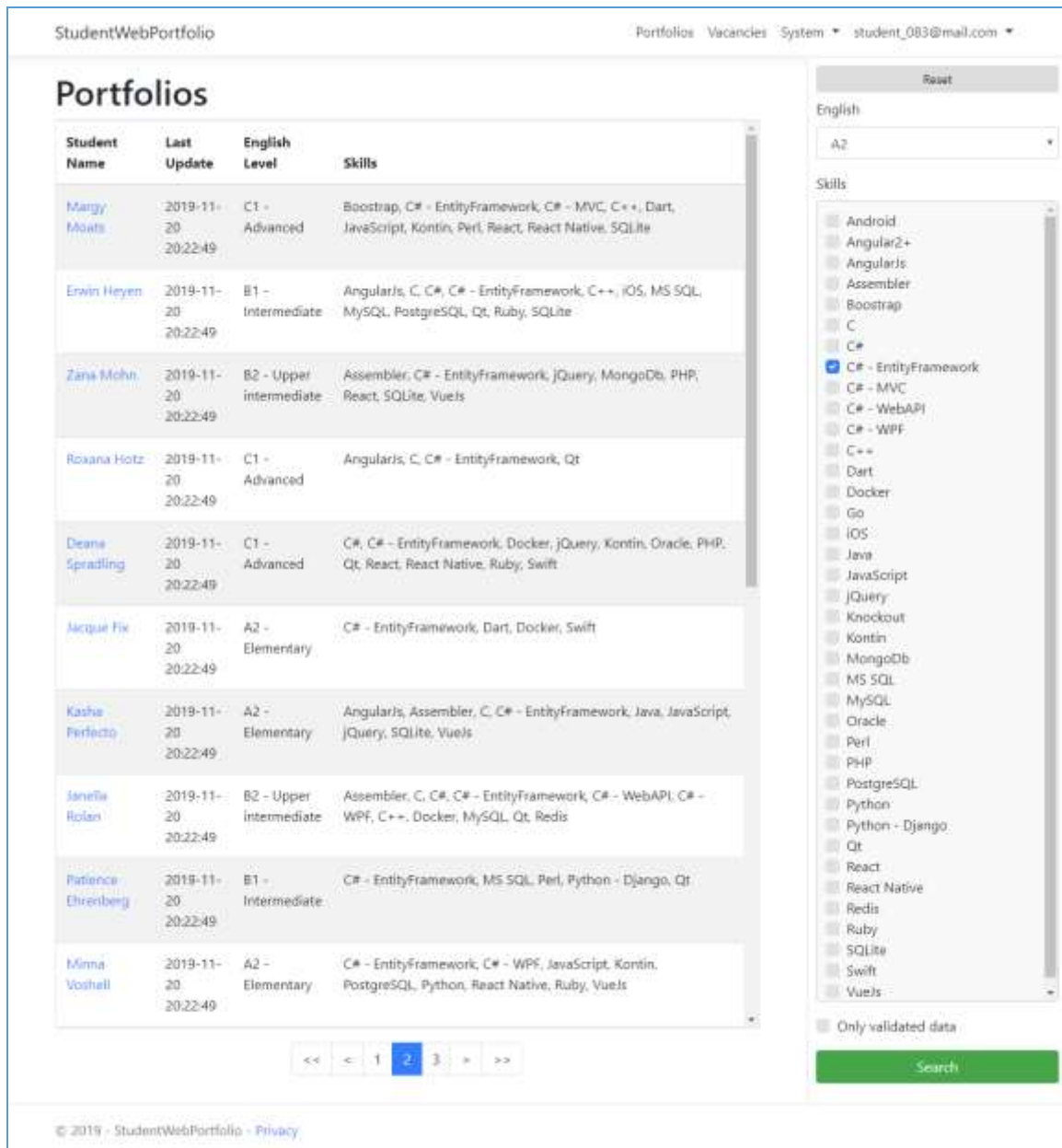


Fig. 6. Portfolio search page

A useful addition to the system is its ability to adapt to change through user experience. The list of system skills can be updated, so if the current list of skills does not have new technology that the user wants to include in his portfolio or job, the user can add it independently. Such functionality is available to all validated users of the system. One can view a list of currently awaiting confirmations. Once the added skill is validated by teachers or employers, it will appear in the mail list of skills.

For the users of the *Teachers* group there is an additional tab *New users*. On this page, teachers can see all the users who are waiting for their identity to be confirmed.

Another important component of virtually any system is the admin panel. This mechanism is

necessary for correcting erroneous data in the system, managing users, viewing all system information and more.

During testing of the developed information technology the following functions were tested: registration, logging in, filling in the profile, viewing profile, editing profile, adding new skills, editing, changing, deleting skills, identity verification, skills verification, portfolio search, job search. All tests included checking for access by users who did not have access to the tested functionality. Separately, *SoupyUI* was used to test the security of the system. In this software, one can make requests to a web server of any complexity. Possible settings include query types such as *POST* and *GET*, *Cookie*, *Header*, and *Local / Session Storage* settings.

The screenshot shows the 'Portfolios' section of the StudentWebPortfolio application. The main content is a table listing various portfolios, each with a company ID, last update date, English level, and a list of skills. A search sidebar on the right allows filtering by English level (currently set to 'A2'), company name, and a list of skills. The skills list includes technologies like Android, Angular2+, C#, JavaScript, Python, etc. A pagination bar at the bottom indicates the current page is 1 out of 10.

Company	Last Update	English Level	Skills
Company_175	2019-11-25 23:44:03	B1 - Intermediate	C# - MVC, Lisp, MySQL, React Native
Company_93	2019-11-25 23:44:03	B1 - Intermediate	Angularjs, Assembler, C# - WebAPI, iOS, MongoDB, MS SQL, Perl, PHP - Laravel, Python, R, Redis
Company_169	2019-11-25 23:44:03	B2 - Upper intermediate	Assembler, Dart, Go, Kotlin, MS SQL, Objective-C, PostgreSQL, React Native, Ruby
Company_225	2019-11-25 23:44:03	A2 - Elementary	Angular2+, C# - WebAPI, F#, iOS, Oracle
Company_237	2019-11-25 23:44:03	B1 - Intermediate	Assembler, C# - WPF, Dart, Knockout, SQLite
Company_42	2019-11-25 23:44:03	B1 - Intermediate	Angular2+, Angularjs, Bootstrap, C# - EntityFramework, C# - WebAPI, C# - WPF, JavaScript, Python, Redis, SQLite
Company_189	2019-11-25 23:44:03	C1 - Advanced	C# - WPF, Erlang, jQuery, MongoDB, Python, Ruby, SQLite
Company_125	2019-11-25 23:44:03	B1 - Intermediate	C#, C# - EntityFramework, C# - WebAPI, iOS, Lisp, MS SQL, Oracle, PostgreSQL, Python, R
Company_47	2019-11-25 23:44:03	A2 - Elementary	Android, PHP - Laravel, PostgreSQL
Company_229	2019-11-25 23:44:03	B1 - Intermediate	Angularjs, Assembler, C, C# - WebAPI, JavaScript, PHP - Laravel, PostgreSQL, Python - Django, R, Ruby

Fig. 7. Job search page

CONCLUSIONS

Electronic portfolios have become a popular alternative to paper portfolios as they provide the ability to view, communicate and provide feedback asynchronously. Using electronic portfolios by IT students enables reflecting their work, an online student portfolio can be shared with a potential employer or used to keep record the achievement of a program or course of study.

The author designed and developed components of information technology designed to improve the accounting of students' professional skills and to

improve the process of finding relevant information for employers in the IT industry. Existing information technologies of accounting of professional skills of IT specialists, their advantages and disadvantages were analyzed. Models are developed and basic requirements for the created information technology were set. The logical model of the system and the model of system usage were developed. A portfolio and job search algorithm has been developed, the algorithm takes into account preview statistics, displays the most relevant portfolios initially, and personalizes jobs for each user.

To implement the developed system in the activities of educational institutions that train IT

professionals, some calculation of economic indicators should be performed. It is necessary to take into account the costs of software development, its debugging and pilot exploitation. Costs for purchased items, shipping costs and more will also be included.

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