The Use of Neural Network Technologies in the Electronic Information and Educational Environment in the Formation of Digital Skills

Julia V. Torkunova
Institute of Economics and Digital Technologies
Kazan State Power Engineering University
Kazan, Russia
torkynova@mail.ru

Diana M. Korosteleva
Institute of Computational Mathematics and IT
Kazan federal University
Kazan, Russia
korosteleva.professional@yandex.ru

Ilya P. Alekseev
Institute of Economics and Digital Technologies
Kazan State Power Engineering University
Kazan, Russia
nemo.alexo@mail.ru

Olga I. Bogomolova
Informatics and Applied Mathematics department
Kazan State Technological University
Kazan, Russia
boikfti@yandex.ru,

Natalia K. Petrova
Institute of Economics and Digital Technologies
Kazan State Power Engineering University
Kazan, Russia
nk_petrova@mail.ru

Abstract—**The development and growth of the digital economy necessitates the acquisition and development of digital skills in the majority of the population. During the study, digital skills were divided into 4 levels: "digital literacy", "digital culture", "digital competence" and "digital professionalism". Considering the possible volumes of training and the contingent of students, the formation of such skills should be carried out in an electronic information and educational environment in a distance format. The aim of the study is to identify opportunities for the use of neural network technologies in the formation of digital skills in the remote format. The classification of neural network technologies is described, and a functional analysis is carried out. It was concluded that according to the results of questioning and input testing, neural network technologies automatically classify users according to levels: digital literacy, digital culture, digital competencies, or digital professionalism. Neural network clustering allows you to differentiate learning by identifying a learner in a particular cluster with a specific pace and content of learning. Neural network regression technologies reveal the most successful and most difficult areas of educational content and based on the identification of dependencies, individualized task pools are proposed. Neural network forecasting technologies allow us to design an individual trajectory of both training and further professional development, and based on the analysis of the Internet content of HR-services offers, possible vacancies are searched for and offered to those trained when profiles match.**

Keywords: neural networks, distance learning, digital skills, differentiation and adaptability of learning, electronic educational environment, neural network technologies in education

I. INTRODUCTION

The intensive growth of the world market of artificial intelligence systems, the rapid popularization of this area in the domestic science and practice, the objective advantages of artificial intelligence as a factor in business, determine the relevance of the study of the possibilities of using neural network technologies in distance learning.

A successful digital transformation of the educational process requires a constructive discussion of the mechanisms and tools for adapting modern experience in the formation and development of artificial intelligence systems to the practice of distance learning..

II. LITERATURE REVIEW AND RESEARCH METHODOLOGY

Modern electronic information and educational environment ensure the formation of digital competencies by providing accessible educational content, an environment for interaction between students and teachers, regardless of the time and location in the distance learning mode. Education in such an environment is carried out remotely.

Distance learning is a set of technologies that provide the trainees with the delivery of the main volume of the material being studied, interactive interaction between trainees and teachers in the learning process, providing trainees with the opportunity for independent work on mastering the studied material, as well as in the learning process.

The term "Distance Learning" is perceived by many experts as an analogue of the term e-Learning . However, this is absolutely not the case. The concept of e-learning is much broader than the concept of distance learning. E - learning (abbr. From English Electronic Learning) - e-learning system. It is synonymous with terms such as e-learning, distance learning, learning using information and electronic technologies. There is a definition given by UNESCO experts: " e-Learning - learning via the Internet and multimedia".

Historically, the priority in the field of informatization of education belongs to the United States. From the beginning of the 90s in America, the America 2000 program was developed, in accordance with which a new generation of educational institutions with a high degree of informatization was created. This allows students to actively interact with the educational material, independently formulate a learning strategy using telecommunication networks, distance learning, exchange of information with other users. The leading role in this program belongs to the Ministry of Education (Department of Education), in its development contribution to the National Science Foundation (National Science Foundation), other federal agencies, the private sector. As part of the development of this program, a telecommunications network for research and education was created, which should provide any researcher or student with access to the Library of Congress [1] .

An example of the introduction of information technology at all levels is the University of California at Berkeley, founded in 1868, which today is one of the leading research universities in the world. An estimated 31,000 of his students (25% of whom are graduates) receive degrees in 300 different programs. The university includes 14 colleges and schools. The central IT structure of the university - Information Systems and Technologies (IST - Information) is responsible for providing wireless data and voice networks at the university. Systems and Technology. More than 35,000 subscribers are connected to the data network, both inside the campus and beyond. In addition, the IST operates several industrial systems and applications, such as the system of management of financial and human resources, student administrative systems, central-mail, web servers, and many other research and academic programs. IST operates 15 laboratories and classrooms distributed throughout the campus, an informatics museum, and a social sciences computer science laboratory [2].

In our country, e-learning technologies have begun to spread since the early 2000s.

The history of distance learning begins in the early 80s of the last century, when various automated learning systems (AOS) began to appear. AOS capabilities were extremely limited. However, some AOC brought very tangible benefits, despite their limited capabilities. A new stage in the history of distance learning came when personal computers equipped with a graphical user interface, providing playback of multimedia data in various formats, became widespread. The use of multimedia capabilities of personal computers has significantly expanded the use of computer-based training systems. Technologies of training of the second generation received the name - Computer Based Training (CBT) - computer training. The modern stage of the history of distance learning has come with the advent of the global Internet. Internet application services and the ability to provide access to educational content from virtually anywhere in the world made it possible to make a significant breakthrough in the development of the use of information technologies in the educational sphere. From this point on, the use of the term "Distance Learning" begins. Due to the widespread use of multimedia and Internet technologies, the efficiency of distance learning has not only become equal to the effectiveness of learning conducted in traditional full-time form, but in many cases has exceeded it, which has led to the rapid expansion of the use of distance learning technologies.

There are two categories of effective ¬ Distance Learning:

1. Undistorted should provide the fullest possible interactivity between the student and the claimed tutor, inverse relationship between student and educational material.

2 It is extremely important to provide highly effective feedback so that students can be sure that they are on the right path from ignorance to knowledge [3].

The use of artificial intelligence will significantly change the distance learning technologies and bring the history of distance learning to a new stage, the possibilities of which will be limitless. Modern distance learning systems provide: centralized automated learning management; quick and effective placement and provision of educational content to students; a common platform for solving basic tasks in the framework of planning, conducting and managing all training activities in the organization; support of modern standards in the field of distance learning technologies; personalization of educational content and the possibility of its repeated use; a wide range of means of organizing interaction between all participants in the educational process. The main tool (not always mandatory) used in distance education is a distance course, in which students acquire knowledge and acquire the skills and abilities they need. The rest of the tools used in distance learning are usually used in conjunction with distance courses. Separate their use significantly reduces their effectiveness. A distance course may contain a large range of elements: information slides; software simulations; interactive simulators; tests; role exercises etc. In addition to the various elements included in the distance learning course to provide students with the knowledge and develop the necessary skills and knowledge to use remote pc including information as to

his means of training should be carried out remotely. In most cases, the distance learning course includes the rules that determine how the listener moves from section to section of a distance course with the passage of distance learning. Very often, the list of such rules is called ''the distance learning path''.

Such an electronic information and educational environment should be aimed at building digital skills in the following four levels: "digital literacy", "digital culture", "digital competence" and "digital professionalism". Digital literacy is the ability to use digital technologies, to apply them in educational activities, to have the skills to search for information, its presentation. Digital culture - the ability to confidently, effectively and safely apply digital technologies, work in the information-educational environment. Digital competence - the presence of a digital culture in combination with the skills of using digital technologies in professional activities. Digital professionalism - self-development of digital systems and technologies, skills for improving the existing ones [4].

To justify the use of neural network technologies in such a learning environment, we consider in more detail the process of obtaining a solution using a neural network, which can be divided into stages:

- creation of a neural network (network architecture, number of layers, transfer functions, initial weights are selected);

- its training (the neural network is fed to the input values, with known answers, the network makes a decision, and the weights are adjusted in accordance with the correctness of the decision; the training continues until the results of the network's decision are satisfactory);

- problem solving (after the network is trained, it can be used to solve practical problems).

Machine learning includes many different algorithms that are applicable to solve problems. The difficulty lies in the fact that among a large number of machine learning algorithms, choose the one that will cope with the solution of the question posed better and more efficiently than others. Each algorithm is designed for a specific functional [5].Attention should be paid to the most basic differences, such as NA teaching methods. There are two cases of machine learning algorithms:

- learning with a teacher;

- learning without a teacher.

Teaching Algorithm with a Teacher (Supervised learning) is one of the sections of machine learning, dedicated to solving the following problem: there are many objects (situations) and many possible answers (responses, reactions) [6]. There is some correlation between answers and objects, but it is unknown. Only a finite set of precedents is known— the "object, response" pairs, called the training set . On the basis of these data, it is required to restore the dependence, that is, to build an algorithm capable of producing a sufficiently accurate answer for any object. To measure the accuracy of the answers, the quality functional is introduced in a certain way.

There is also training without a teacher , when answers are not given at the sample sites. Learning without a teacher is often contrasted to learning with a teacher, when for each learning object a "correct answer" is given, and it is required to find a causality between objects and answers.

Learning without a teacher (Unsupervised learning) is that the algorithm receives only pure data as input. The task of the algorithm with this approach is the observation and classification of the supplied data. In this case, an internal grouping occurs due to which the neural network begins to recognize and relate data to one or another of its own samples [7].

When solving problems using a neural network of the neural network are selected standard configuration, but given the complexity and features of the problem how to find existing configurations can be problematic. If the task cannot be reduced to any of the known types of neural network, it is necessary to solve the complex problem of the synthesis of a new configuration.

To determine the structure of the neural network model, it is necessary to solve several problems: to construct a classification of neural networks; analyze existing neural networks; develop basic neural network selection criteria for model building; determine the main characteristics to determine the quality of the model based on the neural The main characteristic of the neural network is the network model. It is possible to characterize neural networks by the types of neurons used in the network, the structure of the network model, the methods of network training, the tasks that the network solves. Considering the tasks solved by neural networks, a wide range of data processing and analysistasks can be identified . - the recognition and classification of images, forecasting, management, cluster analysis, approximation, neural network compression DATA X , associative memory etc.

According to the structure of connections, neural networks can be divided into :

1. Completely connected neural networks in which each neuron transmits its output signal to the rest of the neurons, including itself. All input signals are given to all neurons. The output signals of the network can be all or some of the output signals of neurons after several cycles of network operation[8].

2 The incompletely connected neural networks (described by the incompletely connected oriented graph and commonly called perceptrons) are divided into single-layer (simplest perceptrons) and multi-layered, with direct, cross-sectional and feedback connections. In neural networks with direct connections, the neurons of the j-th layer can only be connected via inputs to the neurons of the underlying layers. In neural networks with cross-connections, connections within a single layer are allowed [9] .

In turn, the following types are distinguished among multilayered neural networks.

Monotone. This is a special case of layered networks with additional conditions for connections and neurons. Each layer except the last (output) is divided into two blocks: exciting and inhibiting. Relations between the blocks are also divided into braking and exciting. If only excitatory connections are conducted from the neurons of block A to the neurons of block B, this means that any output signal of the block is a monotonous non-decreasing function of any output signal of block A. If these connections are only inhibitory, then any output signal of block B is a non-increasing function of any output signal of block A. Neurons of monotone networks require monotonic dependence of the output signal of the neuron on the parameters of the input signals[10].

Networks without feedback. In such networks, the neurons of the input layer receive input signals, transform them and transmit to the neurons of the first hidden layer, and so on up to the output, which outputs signals for the interpreter and the user. Unless otherwise stated, each output signal of the q-th layer will be fed to the input of all neurons (q + 1) - g o layer; however, a variant of the connection of the q-th layer with an arbitrary (q + p) -th layer is possible[11].

Networks with feedback. In networks with feedback, information from subsequent layers is transmitted to previous ones.

Neural networks can be divided by types of neuron structures into: homogeneous; heterogeneous.

Homogeneous networks consist of neurons of the same type with a single activation function, and neurons with different activation functions enter a heterogeneous network[12].

The activation function of the neuron determines the nonlinear transformation carried out by the neuron[13]. There are many activation functions.

With a linear transfer function, the signal at the output of a neuron is linearly related to the weighted sum of the signals at its input.

In artificial neural networks with a layered structure, neurons with transfer functions of this type, as a rule, constitute the input layer. In addition to a simple linear function, its modifications can be used. For example, a semilinear function (if its argument is less than zero, then it is zero, and in other cases - behaves as linear) or step function (linear function with saturation)

Sigmoidal transfer function is one of the most frequently used types of transfer functions at the moment[14] The introduction of sigmoid- type functions was due to the limitations of neural networks with a threshold neuron activation function — with such an activation function, any of the network outputs is either zero or one, which limits the use of networks not in classification tasks. The use of sigmoidal functions made it possible to switch from binary outputs of a neuron to analog ones. Transmission functions of this type, as a rule, are inherent in neurons located in the inner layers of the neural network.

The radial basis transfer function takes as an argument the distance between the input vector and some pre-specified center of the activation function. The value of this function is the higher, the closer the input vector is to the center [15]. Network with neurons that use these functions are called RBF - networks .

In real networks, the activation function of neurons may reflect the probability distribution of a random variable, or denote any heuristic dependencies between the values.

The functions listed above are only part of the set of transfer functions used at the moment. Another classification divides neural networks into : synchronous; asynchronous.

In the first case, at each time point, only one neuron changes its state, in the second, the state changes immediately for a whole group of neurons, as a rule, for the entire layer. Algorithmically, the course of time in neural networks is given by the iterative execution of the same type of actions on neurons.

When solving problems using the neural network are selected standard configuration of the neural network , but given the complexity and features of the problem how to find existing configurations can be problematic. If the task cannot be reduced to any of the known types of neural network , it is necessary to solve the complex problem of the synthesis of a new configuration.

To determine the structure of the neural network model, it is necessary to solve several problems: to construct a classification of neural networks; analyze existing neural networks; develop basic neural network selection criteria for model building; determine the main characteristics to determine the quality of the model based on the neural network.

Also determine the various learning algorithms for inputs and outputs.

When learning by input, the learning example is only a vector of input signals, and when learning by outputs, it also includes the output signal vector corresponding to the input vector.

By way of presenting examples, they are distinguished: the presentation of single examples, the presentation of a "page" of examples.

In the first case, the change in the state of the neural network (training) occurs after the presentation of each example. In the second - after the presentation of the "page" (set) of examples based on the analysis of all of them at once.

The publication of Emil Zainetdinov is devoted to the possibilities of using artificial intelligence in education   in which he identifies a number of areas of its use in education.

Automatic assessment of the quality of knowledge: and artificial intelligence evaluates a student's essay in a few moments and gives an assessment, giving individual corrections. The program is able to create personalized study plans that will help reduce student errors.

Update student's' knowledge: Peter Wozniak invented a learning application that is based on the effect of the interval. The application is able to track the materials studied by the

user and the time when this happens. With the help of artificial intelligence, the application fairly accurately calculates the date when the user is likely to forget what he taught. And then a smart assistant will remind you of this. A few reminders and knowledge will forever remain in memory.

Teacher level assessment: modern technologies, such as chatbots based on artificial intelligence, machine learning and processing of the human language, can improve the quality of assessment. The most well-known technology, and besides, the most effective - chatbots, which are able to collect feedback about teachers through an interactive interface. From a person is required only to write a review, analytics remains for the bot. The dialogue can be personalized according to the nature of the student.

Virtual assistants: at Georgia Institute of Technology students liked the new teacher's assistant - Jill Watson, who responded quickly and accurately to questions from the students. But they could not even assume that it is not the teacher who communicates with them, but artificial intelligence. The bot itself was equipped with an IBM-AI system.

Campus chat: After the project is 100% completed, it will begin to notify students about the life of the institution. In addition, he will learn how to find lecture halls, accept applications, search for parking and contact professors.

Personalized learning: This type of learning represents a variety of educational programs where the learning process is optimized for the nature of each student[16]. In drawing up such plans, the preferences of the student and his interests are taken into account. Artificial intelligence is able to adapt to the level of learning productivity, and over time increase the complexity of learning. Thus, no one will stand aside and continue to study comfortably, without going beyond their capabilities and not adjusting to the capabilities of others.

Adaptive Learning: When using this technology it will be possible to engage in tracking progress of individual students and to correct course for everyone. The program itself will notify teachers of materials that are difficult to understand a student.

Tracking the integrity of the student: protection systems based on artificial intelligence. Proctoring or Proctored Test - a mechanism that ensures the integrity of the student and does not allow him to deceive the one who takes the exam.

Data collection and selection of materials: For example, artificial intelligence will be able to select content of interest to the user, which will be selected based on his preferences [17].

The following types of tasks can be distinguished using artificial neural networks for solving distance learning tasks in the operation of an electronic information and educational environment.

1. Classification. The neural network approach is especially effective in peer review tasks because it combines the computer's ability to handle numbers and the ability of the brain to generalize and recognize. In the education system, the classification of students and teachers, depending on various factors, can be attributed to this type of tasks. For example, on the basis of the applicant's personal data, the neural network model will assign it to one or another class, which will make it possible to make a qualitative and objective decision when selecting students. Classification is another method of teaching with a communication-based teacher. His main task is the analysis of the training sample, so you can draw conclusions about the belonging of this object to a particular class. All categories of classification are pre-defined [18]. The algorithm works on the principle of learning and testing. At the testing stage, it is supplied with unobservable data and classifies them into categories based on the learning phase.

Search addictions. The neural network allows you to build the dependence of one parameter from others as a complex function on the basis of a training sample. Such a network can not only instantly learn the multiplication table, but also find complex hidden dependencies in data that are not detected by standard statistical methods. The neural network model will help in this case to determine the most important factors affecting a specific indicator of the quality of education [19]. For example, to determine the most significant factors affecting the quality of education in the university. Knowledge of this information will effectively manage the quality of education.

Clustering is the splitting of a heterogeneous set of examples into several areas (clusters), according to some common features, and the number of clusters is not known in advance [20]. Clustering allows you to present heterogeneous data in a more visual form and then use different methods to study each cluster. For example, in this way it is possible to quickly identify groups of students or employees who are close in the analyzed features. Undoubtedly, further analysis of such groups is necessary to give it a generalized characteristic. It is worth noting that the input the data for the algorithm for solving this problem should be unclassified data and parameters, on the basis of which common features are established. Selection criteria are created by the user, which greatly simplifies the work without loss of quality.

The advantages of this algorithm are that the differentiation classes are not defined in advance, so that the neural network will be able to group itself and predict the results without relying on ready-made options. Of the downsides, it is worth emphasizing the lack of accuracy (incorrect clustering), since, depending on the situation, the data may become more priority (to have more weight), although the essence remains the same.

Forecasting. Neural networks are widely used to predict various factors, indicators. They can be used to assess the dynamics of the quality of education, to predict various characteristics of students and teachers. On the basis of forecasts obtained using neural networks, decision-making systems are built [21]

Considering that the differentiation of training is an organization of the educational process, in which individual-typological personality traits are taken into account (general and special abilities, level of development, interests, psycho-physiological properties of the nervous system, etc.), characterized by the creation of groups of students in which

the content of education, teaching methods, organizational forms differents has a direction of use of neural network technology .

Consideration of the theoretical positions of the sources indicates the need for further research and a clearer definition of machine learning methods in relation to the problems of building individual learning trajectories, analysis of preparedness and viewed material in the formation of digital skills.

III. RESULTS

Already at the first stage, when a student applies to an electronic-educational environment based on the results of questionnaires and input testing, we use classification methods, defining a particular group on the formation of digital literacy, digital culture, digital competencies or digital professionalism. For the most complete analysis of the student, we consider it useful to collect all the information about the educational process, starting with school education: performance in all subjects, participation in various competitions and sections, etc. and complete it with the results of questionnaires and entrance testing. Based on the results of the classification, we can offer the student the most suitable directions and specialties of education personally for him.

Using clustering methods, we define a student in a particular cluster with a specific pace and content of training. During the educational process, redistribution of students between clusters is possible.

In the course of training and proposing solutions to various tasks, we identify the most successful and most difficult areas of educational content and, based on the identification of dependencies, we offer additional training and a set of tasks for "difficult sites".

During various practices, we take into account all the information received (as well as the preferences of the student) and select the most suitable base of practice.

After analyzing the learning outcomes for one or another educational block using the forecasting method, and based on the analysis of educational achievements, a further educational trajectory is proposed and proposed. If the student has reached the level of digital professionalism with the help of data mining, the system searches for possible vacancies and offers them to be trained when profiles match up.

For the successful application of the above methods directly involved in the learning process, it is necessary to develop a system that allows you to collect and prepare a sufficient amount of input data, since the quality of the data used directly affects the result of the use of neural network technologies.

The novelty of the study consists in determining the methods of neural network technologies that can be used to solve problems of differentiation in training, as well as in determining the need for preliminary data collection of a specific nature in the construction of individual educational trajectories.

IV. DISCUSSION

The research paper has been demonstrated that the clustering techniques serve as powerful tool in educational data mining. Here various clustering algorithms are discussed and by using these algorithms student's digital competence level is evaluated. The survey of clustering shows the majority of research paper used K-means clustering algorithm for evaluation and exploration. Furthermore, this work describes that making use of cluster analysis to group student according to their features which can be used for the effective and faster results of graduate employment dynamics prediction.

By concluding, research is presented as a guide for the educational system in order to improve their decision-making processes regarding the differentiation of studies and the prediction of student employment outcomes. With that, the suitable choice of clustering algorithm that justifies the research questions on student's data can be more effectively used for performance analysis from the large data set.

V. CONCLUSION

One of the main reasons for this development of neural network technologies and their popularity in our time is their being in demand in solving business tasks and problems. However, the described methods can be of great benefit in other areas, in particular in the field of education. In this regard, we consider it important to research and find their application in the formation of digital skills.

Thus, modern neural technologies allow to automate the process of analyzing and finding correspondences, classifying and clustering data, establishing dependencies, providing differentiation and better, targeted implementation of distance learning digital skills.

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