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ARTIFICIAL INTELLIGENCE BASED ON TENSORFLOW IN EDUCATIONAL PROCESS

*This article discusses the problem of using the TensorFlow library for educational purposes. The main idea of the work is to analyze AI software solutions for students supporting based on the TensorFlow framework. Technological prerequisites are described; reviewed the fundamentals of TensorFlow-based AI systems. In this article, we will first illustrate the state of the art in the application of TensorFlow to educational problems. The paper analyzes the existing areas of application of software products based on the TensorFlow library. In conclusion, the classification of application areas of the software, which is based on TensorFlow, is carried out. **The methodology** for solving this problem is to identify the main types of problems in Artificial Intelligence based on TensorFlow and describing of a main directions TensorFlow-based solutions in Educational Process. **Scientific novelty.** The article shows that the use of the TensorFlow library for educational purposes, which is based on vectors and matrixes mathematics and Deep Learning, allows the implementation of artificial neural networks principles with Artificial Intelligence methodology.*

Key words: TensorFlow library, artificial intelligence, software products, neural networks.

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ШТУЧНИЙ ІНТЕЛЕКТ НА ОСНОВІ TENSORFLOW В НАВЧАЛЬНОМУ ПРОЦЕСІ

У цій статті обговорюється проблема використання бібліотеки TensorFlow в навчальних цілях. Основна ідея роботи – проаналізувати рішення інтелектуальних програмних продуктів для студентів, які навчаються на основі фреймворку TensorFlow. Описано технологічні передумови; переглянуті основи систем інтелектуальних програмних засобів на основі TensorFlow. У цій статті ми спочатку проілюструємо

сучасний рівень застосування TensorFlow до освітніх проблем. У статті аналізуються існуючі сфери застосування програмних продуктів на основі бібліотеки TensorFlow. На закінчення проводиться класифікація сфер застосування програмного забезпечення, яка базується на TensorFlow. **Методологія** вирішення цієї проблеми полягає у визначенні основних типів проблем штучного інтелекту на основі TensorFlow та описі основних напрямів рішень на основі TensorFlow в навчальному процесі. **Наукова новизна.** У статті показано, що використання бібліотеки TensorFlow в навчальних цілях, яка базується на векторах і матрицях математики та глибокого навчання, дозволяє реалізувати принципи штучних нейронних мереж з методологією штучного інтелекту.

Ключові слова: бібліотека TensorFlow, штучний інтелект, інтелектні програмні продукти, нейронні мережі.

Nowadays, in the age of information, educational organizations more and more often use different kinds of information technologies to automate their working process. However, not all the problems are resolved. In addition, educational process rapidly makes a transition to the online format, so new challenges appear. Some of educational process issues, related with student teaching, student supporting, teacher supporting and data analysis, are directly connected with tasks of recognition, making decisions, classifying and analyzing a large amount of data. Tasks of this kind are quite difficult to solve with standard programming approaches and this is a problem. However these tasks are typical for artificial intelligence (AI).

The use of AI in education has been the subject of different researches for about last 30 years. AI solutions bring new possibilities and perspectives for development of education. AI can provide a high level of efficiency, curriculum personalization and give teachers enough time to solve tasks connected with coaching, advisement, behavioral-, social-, and emotional- skill development. It is difficult for machine to deal with such a human capabilities. Using both best functions and possibilities of AI and humans in education can have a positive impact on students' outcomes.

Currently, there are a large number of artificial intelligence software solutions. One of these solutions is the TensorFlow library. TensorFlow is a free and open-source software library for machine learning. It can be used across a range of tasks but has a particular focus on training and inference of deep neural networks. TensorFlow is a symbolic math library based on dataflow and differentiable programming. It is used for both research and production at Google.

So using AI in systems for automation some aspects of educational process, including student teaching, student supporting, teacher supporting, data analysis, etc., is very actual. There are no such systems implemented in Ukrainian educational platforms, but some experimental systems exist in other countries [2; 3; 6; 7; 8; 11; 13; 16; 25; 26; 29].

Using AI in educational process certainly has its own benefits and future perspectives, but it also may cause some problems. Typical problems in AI use are: time for training, high cost of development, detection of wrong patterns, wrong interpretation of results and risk of unemployment.

The objectives of this study are:

- To provide an overview of AI software solutions for teaching students based on the TensorFlow library.
- To create a classification of these software products.
- To determine a direction for development of AI solutions based on TensorFlow.

Software products based on TensorFlow in education.

AI application in student teaching

Student teaching is a perspective subject area for AI application. AI can be used for customizing learning process, creating virtual tutor, etc. AI can create ideal environment in which students can study and develop successfully.

With AI methods it becomes possible to customize learning process to individual student's needs, increasing student's performance. One of widespread educational problem is that there exists a huge difference in basic knowledge between students in one group. Especially if this group contains about 30 people. Teachers are usually oriented on some abstract average student, using "one-size-fits-all" approach, because curricula are usually formed without a single hint of an individual approach to students. Curricula are a kind of rigidly fixed set of knowledge that all students must learn, regardless of their capabilities or interests and this is a problem. As a result of "one-size-fits-all" approach "weak" students are not able to properly understand learning material and "strong" students are bored and don't get any progress during lessons. Unfortunately, this is very widespread situation today. That is why using AI in this case is good solution. AI software potentially is able to give teachers useful information about students' learning styles, abilities, academic performance, and provide suggestions how to adjust teaching/learning strategy for each student.

Nowadays some companies are currently developing educational systems with AI which are able to teach student, check his or her knowledge, identify gaps and give feedback about student's performance. These systems give students challenges they are ready for and redirects to new topics when it is appropriate. Such software usually used for language learning.

For example, in [7], methods of deep learning of artificial neural networks are considered, which help to determine the probability of student expulsion, as well as suggesting to change the training route. These solutions helps teachers support students who are struggling and give additional challenges to students who are ready for more. Such approach greatly increase students' motivation and allows teachers to work more effectively.

Systems with AI can be a virtual tutor for students. Because of students sometimes have gaps in their knowledge, there is often a need of extra lessons for specific subjects among students. Nowadays AI can be a teacher, which provides personal tutoring and support for the students outside of the classroom. Such technology can provide personalized help for students to keep up with the course. One of valuable advantages of this technology is that this virtual teacher available instantly whatever the time.

Bright examples of this kind of software are AI-powered chatbots and AI virtual personal assistants.

AI application in student supporting

AI can be used for student supporting. Many kinds of repetitive tasks could be automated using AI technologies. Such software can offer teachers more time to focus on teaching their students rather than discussion topics which are barely related to education subject. When a teacher has hundreds of students, it's very time-consuming to answer lots of same questions about lesson plans, schedules, and guidelines, etc. That is why smart systems like chatbots are good solution for this issue.

There exists an example of chatbot, developed in The University of Murcia in Spain [9], named Lola and it was created to provide immediate answers on students' questions about the areas of study and campus. Administration of university was pleasantly surprised when it turned out that Lola was able to answer more than 38 thousand questions, giving right answers on more than 91% of them.

Another example of chatbot is Ed. It was created by college professor to assist students before, during and outside of his class. Ed could provide access to referenced documents/articles/

biographies, notifications about lessons and feedback on presentation. Ed was not only the instrument to find information the about classes, but it was the instrument of gamifying the learning process and making it more dynamic and active. As the result students were more motivated and professor spent less time answering student messages. According to pool conducted by professor, 99% of student was satisfied with Ed and 98% would like to see more other chatbots in other classes.

Chatbots can be very smart and they can mirror human behavior quite accurately. For example, Ashok Goel, professor of Georgia Tech developed chatbot named Jill Watson [6]. He introduced Jill Watson to students, but they didn't know that the Jill Watson was an AI. Chatbot was answering students' questions about routine topics during semester. Only at the end of the semester, professor revealed Jill Watson's identity and students was very surprised.

The technologies used in the above examples of chatbots differ from the TensorFlow library, however, considers the creation of an intelligent chatbot based on the use of TensorFlow libraries. In this example, the recommended technology is Long short-term memory (LSTM), developed by Sepp Hochreiter and Jürgen Schmidhuber [9].

Scientific research "Intelligent Chatbot using Deep Learning" [26] also discusses building a chatbot based on LSTMs, but also discusses using Google's Neural machine Translation.

Summarizing this section, it should be noted that the use of TensorFlow libraries to support students is an easy-to-do software design element.

AI application in teacher supporting

Another possible area of using AI is teacher supporting. Teachers work about 50 hours per week and spend only 49% of time in direct interaction with students. Rest of the time they spend on preparation, evaluation, and administrative duties. AI-systems can make teachers' life much easier and save a lot of time, giving teachers an opportunity to spend more time teaching students rather than checking assignments or creating and filling reports. So preparation, administration, evaluation, and feedback are areas with biggest potential to automation.

The article of Taiwanese researchers developed on the basis of an in-depth analysis of the student's previous experience, can allow the university to assist students in choosing a course and improving their competencies based on their abilities, potentially reducing dropout rates and promoting adaptive learning, thereby achieving a win-win situation as for university and for students.

AI can be used for automating basic activities, such as grading homeworks and handling examination related activities. Subjective opinion and different marking systems of examiners are main highlights that usually cause a certain level of bias in knowledge assessment. Nowadays the systems for objective type papers evaluation exist and they mostly use OMR technology. There exist the problem of evaluating subjective type papers. For this purpose AI can be used. It is an urgent educational system need. First of all, AI can provide a high level of precision, efficiency and it can save a lot of time because of its possibility to analyze large amounts of data, more than any human. Secondly, AI can guarantee reducing bias in assessment caused by subjective examiner's opinion.

Chinese education is a prime example. By the year 2016 China Ministry of education started a big digital educational experiment. And today 60 000 schools use the system for automatic essay correction with the level of precision matching humans in 92%. The essay grading machine is based on AI neural network and is improving its ability to understand human language by using deep learning algorithms.

Above-mentioned examples show that AI can be trained for grading different kinds of subjective type papers, for example, even code snippets, what is actual issue in IT-education area.

Thus today, essay-grading software is still not ideal, but it is quite close. Improvement such type of software needs years' time. But as a result due to this technology teachers will be able to focus more on interaction with students and in-class activities.

Using the TensorFlow library to teach the basics of AI

A large number of works consider the use of the TensorFlow library for teaching the basics of AI, due to the easy implementation of artificial intelligence components in this library. So, in the works "Deep Learning in the IT Curriculum" [11] and "Development of Artificial Intelligence Education Contents based on TensorFlow for Reinforcement of SW Convergence Gifted Teacher Competency" it is proposed to base knowledge and skills of deep machine learning on the study of the TensorFlow library, as well as to use it in teaching teachers.

Deep learning goes to school: toward a relational understanding of AI in education [x15] and Deep Learning: The Impact on Future eLearning [x14] take a broader view of deep learning knowledge fundamentals. However, in these studies, the impact of the Tensorflow library on the studying process of deep learning is widely reported, and is one of the priority areas for learning.

Application of TensorFlow library for automatic attendance control

Due to the focus of the TensorFlow library on machine learning methods based on examples, one of the areas of support for teachers that is widespread in the world is the analysis of photo and video materials from classrooms. The program automatically recognizes the faces of the students present on the images and generates an attendance report.

So, in the works "The Application of TensorFlow Facial Recognition Technology in Education Assistant System" [8], "Automated student attendance monitoring system in classroom based on convolutional neural networks" [13], "Automatic Attendance Management System based on Deep One-Shot Learning" [16], "TensorFlow-Based Automatic Personality Recognition Used in Asynchronous Video Interviews" [25] is proposed to use convolutional artificial neural networks with small differences in layers, capable of recognizing students' faces.

A little apart is the work "TensorFlow-Based Automatic Personality Recognition Used in Asynchronous Video Interviews" [25], in which, in addition to the student's face, such parameters as Openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism are recognized.

The work proposed in the article "Classroom Attendance Auto-management Based on Deep Learning" [29] also has differences in structure, which also considers a convolutional neural network being trained, in contrast to previous works on the Faster R-CNN algorithm.

Today there exist about several dozen works of this kind, in view of the simple implementation and the known ways of solving this problem.

AI application in data analysis

AI can be used for data analysis. There exist a lot of data in educational institutions that potentially could be gathered and analyzed. But this process is inefficient without automatization.

One of tasks for data analysis is prediction students' academic performance. For this purpose AI can be used. Poor results of students after admission are a big problem for many of educational institutions. Students' progress depends on variety of reasons, such as their socio-economic background, academic performance record, etc. Prediction based on manual analysis of large amount of data is difficult and inefficient because of limitations of human cognition and difficulties of dealing with many different variables. Standard programming algorithms cannot work with such a spread in data sets. In contrast to all mentioned above

methods of analysis, AI can capture a much wider and more detailed array of data.

An example of AI application for data analysis is described in article. According to this article, the test version of a neural network was created and integrated in educational system of “Nicolae Titulescu” University of Bucharest. The neural network analyzed profiles of first-year students and classified them into specific academic performance groups. It was successfully used to predict potential candidates for leaving the university with about 86% of the average predictability rate. This helped institution management to take early actions to avoid academic performance regress and even student leaving education.

Hence AI can be used for analysis and prediction of different aspects of educational process, such as forecasting different academic characteristics of students. This can make educational process more flexible.

AI has an ability to help individual students' with their progress. There exist educational systems which can analyze students' data and produce corresponding recommendations.

Similar models are considered in the works “An Artificial Neural Network Approach to Student Study Failure Risk Early Warning Prediction Based on TensorFlow” [2], “Predictive analytics in education: a comparison of deep learning frameworks” [3], “Pedagogical Data Analysis Via Federated Learning Toward Education 4.0” [7]. In these works, models of artificial neural networks are considered, trained on student data and designed to predict further student results, based on the available data. In the works, the forecast accuracy varies from 70% to 90%, which allows them to serve as an accurate basis for analyzing and predicting the behavior and performance of students.

Possible problems of using AI.

However using AI has not only positive sides. It may have some possible problems, such as:

- Long training. AI software mirror behavior of human and replicate the best practices, but it also needs to be pre-fed with relevant information. It can take up to several months to train AI system.
- Wrong interpretation of results. AI analyzes big amounts of data quite accurately, but the results can be wrongly interpreted or even deliberately misused. Despite the intention of the developers and users of these systems, there could be unintended negative consequences. These consequences can even backfire. For this reason, results of analysis should be used carefully. It should be taken into account that data could have different quality levels, could be outdated, or results could

be focused on non-average specific subset, which influence on bias in analysis results, etc.

- Detection of wrong patterns. The point of AI tools is to show less intuitive, more attenuated correlations and patterns. But AI can detect random unrelated correlations. For instance, in this website there is a list of the strangest correlations detected by AI.

- High cost of development. The exact cost is difficult to estimate, because it depends on many aspects. To demonstrate the expenditure scale, authors of the article predict that AI adoption in education is expected to reach global expenditure of \$6b by 2025. Much of the growth will come from China and USA.

- Risk of unemployment. According to the study conducted by McKinsey Global Institute, intelligent agents and robots could replace about 30% of the world's current human labor by the year 2030. Consequently, many teachers could lose their jobs and this problem should be resolved in some way, for example by staff retraining. But there exist another opinion that teachers are unlikely to lose their jobs because of AI will replace them. They also might lose job because of they don't have enough skills to deal with AI. It means that teachers and administration of educational institutions should have special skills in evaluating and interpreting results produced by AI. Moreover, software always updates and staff should have an ability to accept new things and learn them fast.

Classification of educational software products developed with TensorFlow.

In view of the fact that TensorFlow is considered primarily as a means of managing large arrays of data and transformations in them, the use of TensorFlow in education is quite specific. After analyzing the work offering tools in the field of education, using TensorFlow libraries, it is possible to draw up the following areas:

- Control of classroom attendance of lectures using face recognition.
- Intelligent chatbots for interacting with students and teachers.
- Learning the basics of AI
- Predicting the learning trajectory of students and the risks associated with learning.

The development of artificial intelligence systems using TensorFlow libraries, of course, is also possible in other areas, since the library is universal and freely modifiable. However, the library's focus on processing data arrays and systems based on artificial neural networks gives an advantage in processing system data, in which it is possible to present training based on examples, such as photo and video recognition or prediction of educational trajectories.

Conclusion. AI is an efficient solution that can provide opportunities to optimize and improve some aspects of educational process.

Despite of some possible the problems such as time for training, high cost of implementation, wrong interpretation of results and risk of unemployment which undoubtedly should be taken into account, AI systems can be successfully used for solving many issues in education. These are above mentioned tasks of student teaching, stu-

dent supporting, teacher supporting and data analysis. High cost of implementation can be compensated by the process optimization and reducing costs in the near future. To avoid wrong result interpretation and detection of wrong patterns data should be used carefully and inaccuracies should be taken into account. In this case advantages outweigh disadvantages. It is brightly illustrated by existing experimental systems, mentioned above in this paper.

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